MITSUBISHI

MAGNETIC MOTOR DRIVE UNIT

MELIPM SERIES

SPECIFICATIONS/INSTRUCTION MANUAL

High Performance & High Function

MD-AX520-0.5K to 3.5K

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Please read here first

Thank you for choosing the Mitsubishi Magnetic Motor Drive Unit. This instruction manual gives handling information and precautions for use of the drive unit.
Incorrect handling of the equipment may cause an unexpected fault. To optimize the unit capability, please read this manual carefully before using the equipment.
Please refer to the Mitsubishi Magnetic Motor Instruction Manual for the Mitsubishi Magnetic Motor.

General precautions

- Please forward this instruction manual to the end user.
- Many of the diagrams and drawings in this instruction manual show the drive unit without a cover, or partially open. Never run the drive unit in this manner. Always replace the cover and follow this instruction manual when operating the drive unit.
- After reading this manual, store it carefully in a place where it is easily accessible for the operator.
- This instruction manual is subject to modifications for specification changes and manual improvements. After such modifications have been made, the instruction manual will be published as a revised version with a new number located on the bottom left of the back cover.

For safe operation of this product

- This product has not been designed or manufactured for use in or with a device or system which will be used under circumstances where life may be endangered.
- Consult with Mitsubishi if you are planning to use this product for special purposes, e.g. equipment or systems designed for manned transport vehicles, medical purposes, aerospace, nuclear power, electric power or undersea junctions.
- This product has been manufactured under strict quality control. However, when installing the product where serious accidents or losses could occur if the product fails, install appropriate safety devices in the system.
- Do not use this product with any load other than the specified motor.
- You cannot use a single drive unit with two or more motors.

Safety Instructions

This section is specifically about safety matters

Do not attempt to install, operate, maintain or inspect the drive unit until you have read through this instruction manual and appended documents carefully and can use the equipment correctly. Do not use the drive unit until you have a full knowledge of the equipment, safety information and instructions.
In this instruction manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

⚠ **WARNING**	Assumes that incorrect handling may cause hazardous conditions, resulting in severe injury or death.

⚠ **CAUTION**	Assumes that incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause physical damage only.

Note that the CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personal safety.

NOTICE denotes the items which do not correspond to "WARNING" or "CAUTION" but should be observed by the customer.

MEMO denotes the items which the user should know for operation.

Please read here first (Continued)

1. Usage

⚠ WARNING

- The MELIPM series motor is a synchronous motor with high-performance magnets built in its rotor. Therefore, after the drive unit is powered off, there are high voltages at the motor terminals while the motor is running. Before starting wiring or maintenance and inspection, make sure that the motor has stopped. In any application where the motor is rotated by a load such as a fan or blower, connect a low-voltage manual switch on the drive unit's output side, open the switch, and start wiring or maintenance and inspection. Not doing so can cause an electric shock.
- Never disassemble or modify the unit. Doing so can cause an electric shock, fire or injury.
- Do not use the unit with any load other than the specified motor. Doing so can cause a fire or injury.
- Provide safety devices for the whole system, e.g. emergency brakes, to ensure that the machine or device is not placed in hazardous conditions when the drive unit fails.

⚠ CAUTION

- If a holding brake is required, prepare it separately. The brake function of the drive unit cannot keep holding the load. Injury may result.
- Before operating the drive unit which had been stored for an extended period of time, perform inspection and test operation on the unit before using. Not doing so may cause accidents.

2. Transportation

⚠ CAUTION

- Do not stack the drive unit boxes higher than the number indicated on the package. Doing so can cause injury.
- Confirm the weight before carrying the drive unit. Not doing so can cause injury.
- When carrying the drive unit, do not exert a force partially, i.e. do not hold the front cover operation panel. Doing so can cause the unit to drop, leading to injury.
- The drive unit is precision piece of equipment. Do not drop it or subject it to impact, this may damage the drive unit.

3. Installation

⚠ CAUTION

- Do not install or operate the drive unit if it is damaged or has parts missing. Such installation or operation can cause accidents.
- Always install the drive unit in the specified orientation and environment. Not doing so can cause a fire or accidents.
- Install the drive unit on an incombustible material such as metal. Not doing so can cause a fire.
- Do not place combustible materials nearby. Doing so can cause a fire.
- Install the drive unit in a load-bearing place. Not doing so can cause accidents.
- Prevent screws, metal pieces or other conductive foreign matter, or wood scrap, oil or other flammable foreign matter from entering the drive unit. They can cause a fire or accidents.

4. Wiring

⚠ WARNING

- Any person who is involved in the wiring of this equipment should be fully competent to do the work. Otherwise, an electric shock or fire can occur.
- Install a no-fuse breaker or earth leakage circuit breaker. Otherwise, a drive unit failure can cause large currents to flow, resulting in a fire.
- Always install the unit before wiring. Otherwise, an electric shock or fire can occur.
- Before restarting wiring after power-on, make sure that the motor is at a stop, wait for more than 10 minutes after switching power off, and confirm that the DC voltage across the DC terminals P/+ and N/- is low enough to do the work. Immediately after power-off, the DC terminals P/+, N/- are charged with more than 200V (residual voltage of the internal capacitor). Therefore, an electric shock may occur.
- Even after power-off, the motor connection terminals U, V, W have high voltages while the motor is running. Always start wiring after confirming that the motor has stopped. Not doing so can cause an electric shock.
- Earth the drive unit. Not doing so can cause an electric shock or fire.

⚠ CAUTION

- Make sure that the input power supply voltage matches the rated voltage specifications. Mismatch can cause a fire or accidents.
- Check the terminal layout and terminal symbols to ensure that connections are correct. Wrong connections can cause a fire or accidents.
- Do not connect a power supply to the motor connection terminals U, V, W. Doing so can cause a fire or accidents.
- Connect the motor connection terminals U, V, W to match the motor phase sequence. Wrong connections can cause accidents due to reverse rotation of the motor.
- Do not connect a resistor across the DC terminals P/+-N/-. Doing so can cause a fire or accidents.
- Take measures to prevent peripheral sensors and equipment from malfunctioning due to electromagnetic noises. Not doing so can cause accidents.
- Take measures to prevent peripheral power capacitors and generators from overheating or being damaged due to power harmonics. Not doing so can cause a fire.
- Connect the power capacitor, surge suppressor and radio noise filter (FR-BIF option) on the power supply side. Connection on the output side can cause a fire.

5. Operation

⚠ WARNING

- Always replace the front cover before switching input power on. While power is on, do not remove the front cover. Doing so can cause an electric shock.
- Operate the switches with dry hands. Not doing so can cause an electric shock.
- Prepare an emergency stop switch separately. The "STOP/RESET" key of the operation panel or parameter unit is valid for stopping only when the function setting has been made. Not using a separate emergency stop switch can cause accidents.
- When the stall prevention function is activated, operation will be performed independently of the preset acceleration/deceleration time and preset speed. Design the machine to ensure safety if the stall prevention function is activated. Not doing so can cause accidents.
- Selecting the retry function will restart the drive unit suddenly when it is at an alarm stop. Design the machine to ensure personal safety if the drive unit is restarted. Not doing so can cause accidents.
- At the occurrence of an alarm, turn off the run signal before resetting the alarm. The drive unit will restart abruptly if you reset the alarm with the run signal on. It can cause injury.
- At occurrence of an alarm, turn off the run signal. If you do not turn off the run signal, the alarm may be reset due to power OFF-ON at occurrence of an instantaneous power failure or like, restarting the drive unit suddenly. It can cause injury.

⚠ CAUTION

- You can set the motor speed easily between low speed and high speed. Set the speed command which will not exceed the permissible range of machine design. Not doing so can cause accidents.
- If the motor is rotated by the load, ensure that the motor will not exceed its maximum speed. The drive unit may be damaged.
- While power is on or some time after power-off, do not touch the heat sink and brake resistor as they are hot. You may get burnt.
- The electronic overcurrent protection function for motor overheat protection is initialized when the drive unit is reset. Frequent resetting of the drive unit will disable motor overheat protection. The motor may be burnt if it is operated under overload.

6. Maintenance, Inspection and Part (Cooling Fan) Replacement

⚠ WARNING

- Any person who is involved in maintenance, inspection or part replacement should be fully competent to do the work. Otherwise, an electric shock or injury can occur.
- Before starting maintenance, inspection or part replacement, make sure that the motor is at a stop, wait for more than 10 minutes after switching power off, and confirm that the DC voltage across the DC terminals P/+ and N/- is low enough to do the work. Immediately after power-off, the DC terminals P/+, N/- are charged with more than 200V (residual voltage of the internal capacitor). Therefore, an electric shock may occur.
- Even after power-off, the motor connection terminals U, V, W have high voltages while the motor is running. Always start the work after confirming that the motor has stopped. Not doing so can cause an electric shock.
- Do not conduct a pressure test. A pressure test can damage the drive unit.
- Do not perform an insulation resistance test on the control circuit using a megger. Such a test can damage the drive unit.
- While power is on, do not replace the cooling fan. Replacing the cooling fan during power-on can be hazardous.

7. Disposal

⚠ CAUTION

- Dispose of the drive unit as general industrial waste. Its solder (lead) can cause environmental contamination.

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1. PRE-OPERATION INFORMATION

This chapter provides fundamental information necessary prior to operation of the drive unit.

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<Abbreviations>
- DU
  Operation panel (FR-DU04)
- PU
  Operation panel (FR-DU04) or parameter unit (FR-PU04)
- Drive unit
  Mitsubishi magnetic motor drive unit
- Pr.
  Parameter number
- PU operation
  Operation using the PU (FR-DU04/FR-PU04)
- External operation
  Operation using the control circuit signals
- Combined operation
  Operation using both the PU (FR-DU04/FR-PU04) and external operation

1.1 Checking the Product

Unpack the drive unit, inspect the contents, and check the name plate to ensure that the product agrees with your order.

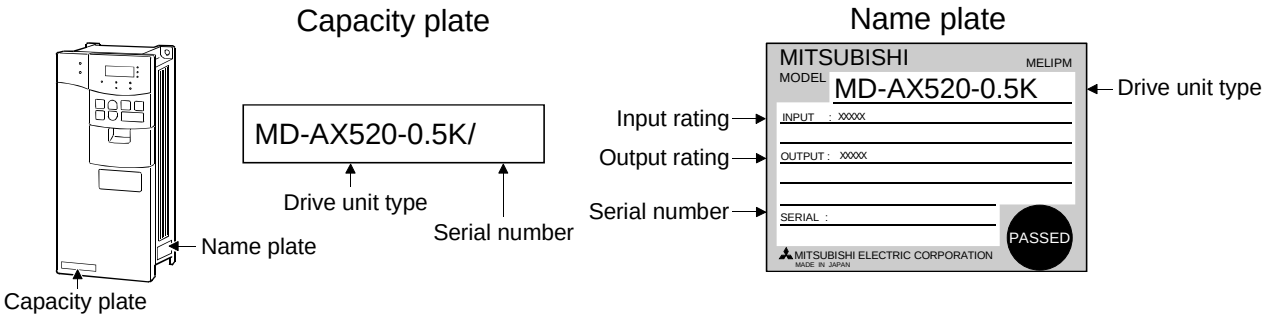
1.1.1 Contents

Contents	Quantity
Drive unit	1
Specification/instruction manual	1
SAFETY INSTRUCTIONS (seal)*	1

* The SAFETY INSTRUCTIONS (seal) are included in the specification/instruction manual.

1.1.2 Type

● Locations of the capacity plate and name plate and definitions of their descriptions



● Type

M D - A X 5 2 0 - □ □ K

Series | Power supply: 3-phase 200V | Capacity

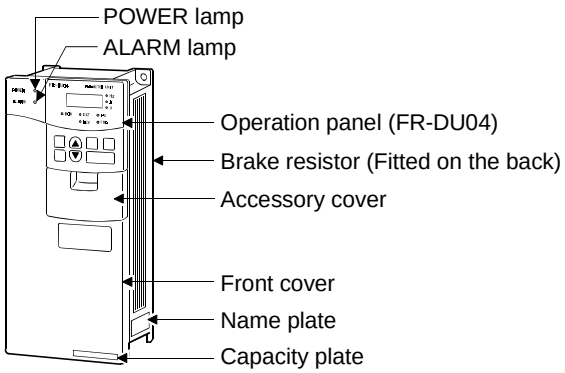
1.1.3 Drive units to be used with motors

Use the drive units and motors in the following combinations.
(The drive unit and motor of the same capacity are used together.)

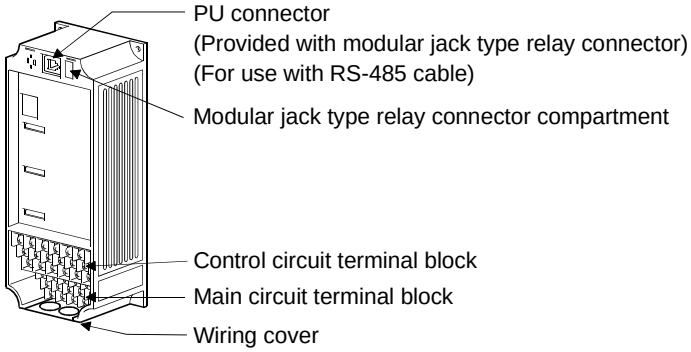
Drive Unit	Motor
MD-AX520-0.5K	MM-CF52
MD-AX520-1.0K	MM-CF102
MD-AX520-1.5K	MM-CF152
MD-AX520-2.0K	MM-CF202
MD-AX520-3.5K	MM-CF352

1.2 Parts Identification

● Appearance of drive unit



● Without front cover

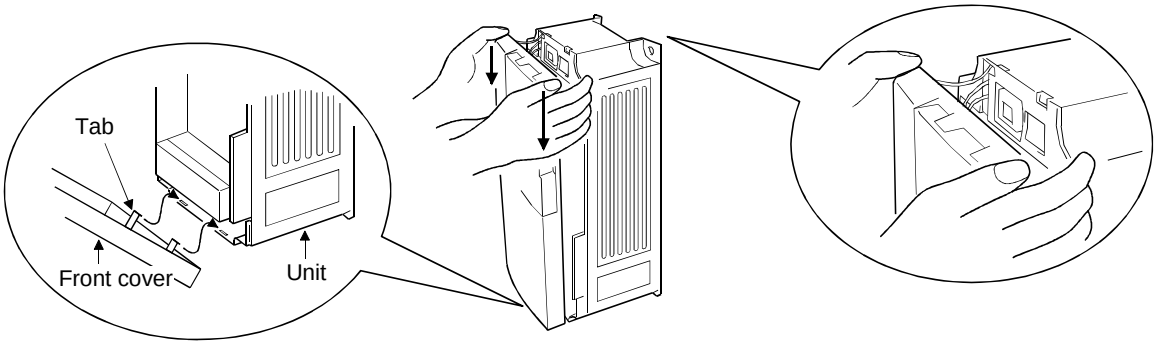


1.3 Handling of the Cover and Operation Panel

1.3.1 Removal and reinstallation of the front cover

● Removal

1) Hold both sides of the front cover top and push the front cover down.
2) Hold down the front cover and pull it toward you to remove.
(The front cover may be removed with the PU (FR-DU04/FR-PU04) on.)



● Reinstallation

1) Insert the tabs at the bottom of the front cover into the sockets of the unit.
2) Using the tabs as supports, securely press the front cover against the unit.

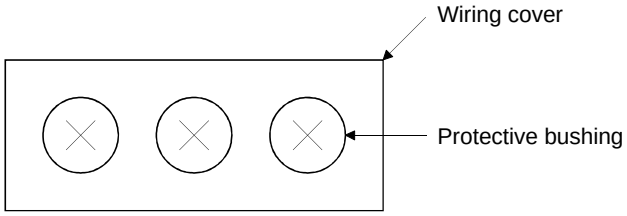
NOTICE	● When reinstalling the cover, fix the tabs securely. ● If the removed front cover has the operation panel on it, remove the operation panel before reinstalling the front cover.

1.3.2 Handling of the wiring cover

Slide the wiring cover toward you to remove.

● When cable conduits are not used

Cut the protective bushes of the wiring cover with snippers or a cutter before routing the cables.



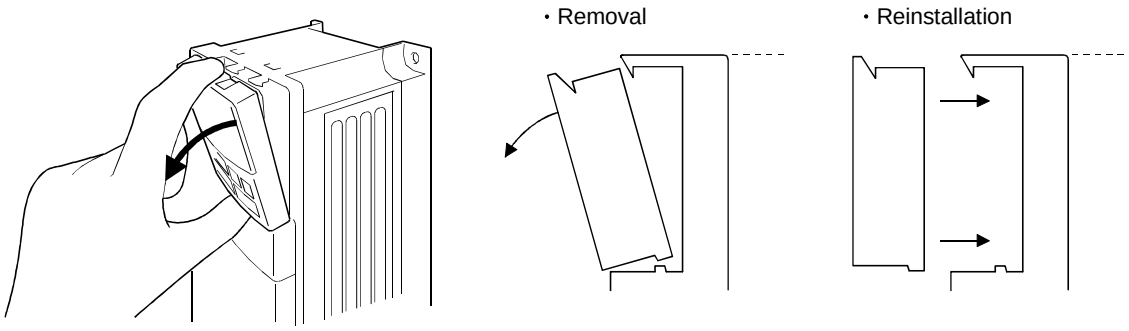
⚠ WARNING
● **Do not remove the protective bushing. Doing so can scratch the cable sheathes by the wiring cover edges, causing a short circuit or ground fault.**

● When cable conduits are used

Remove the corresponding protective bushing and connect the cable conduits.

1.3.3 Removal and reinstallation of the operation panel

Hold down the top button of the operation panel and pull the operation panel toward you to remove.

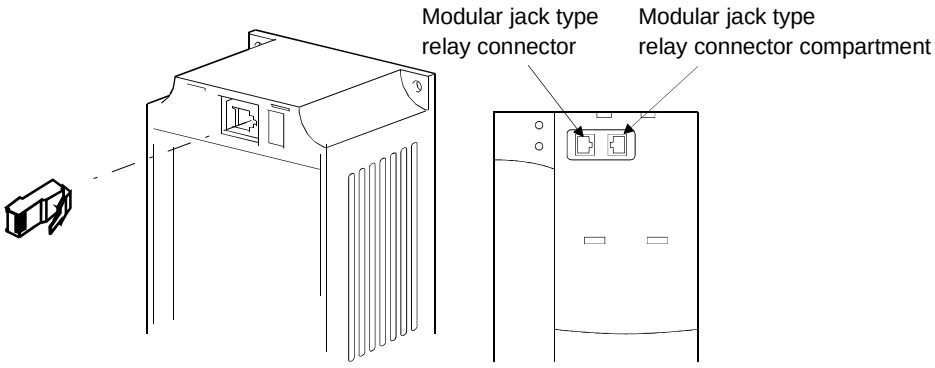


To reinstall, insert straight and mount securely.

NOTICE	● Do not reinstall the operation panel to the front cover which has been removed from the drive unit. Doing so will damage the PU connector.

● Reinstallation using the connection cable

1) Remove the operation panel.
2) Disconnect the modular jack type relay connector. (Place the disconnected modular jack type relay connector in the modular jack type relay connector compartment.)



3) Securely plug one end of the connection cable into the PU connector of the drive unit and the other end into the operation panel.

1.4 Transportation

When carrying, always support the whole drive unit.

1.5 Storage

Store the drive unit in the following environment.

Ambience	No corrosive gas, flammable gas, oil mist, dust and dirt. No exposure to direct sunlight. No salt.
Ambient temperature	-10°C to +50°C (non-freezing)
Storage temperature	-20°C to +65°C (applies to short-time transit)
Ambient humidity	90%RH or less (non-condensing)
Vibration	5.9m/s^2 (conformance with JIS C 0040)

NOTICE	● If the specification value of humidity is satisfied, condensation and/or freezing will occur in places where temperatures vary greatly. Avoid storing the equipment in such places. ● Avoid placing the unit directly on the floor. Place it on a stand or shelf.

2. INSTALLATION

This chapter gives preparatory information on installation and wiring of the drive unit.

NOTICE	● The Japanese harmonic suppression guidelines for suppression of harmonics were established by the Ministry of International Trade and Industries in September, 1994. To comply with the regulation levels determined by the Japan Electrical Manufacturers' Association in accordance with the "harmonic suppression guideline for household appliances and general-purpose products", connect the optional power factor improving reactor (FR-BEL or FR-BAL).

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2.1 Checking the Installation Environment

2.1.1 Operating environment

● General operating environment
Install the unit in the following environment.

Ambience	Indoors (No corrosive gas, flammable gas, oil mist, dust and dirt No exposure to direct sunlight. No salt.)
Ambient temperature	-10°C to +50°C (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Altitude	Maximum 1000m
Vibration	5.9m/s^2 (conformance with JIS C 0040)

⚠ CAUTION
● **Install the equipment on a non-flammable material. Not doing so can cause a fire.** ● **Do not place flammable materials near the equipment. Doing so can cause a fire.** ● **Install the unit in a load-bearing place. Not doing so can cause an accident.**

● Noise environment

Since drive is an electronic piece of equipment, the drive unit may malfunction if there are machines which generate large noises (e.g. welder, power equipment) in the periphery. Fit surge suppressors, noise filters and/or like to the noise sources, install the drive unit as far away as possible from noise sources, or place shielding plates and the like to fully suppress noises.

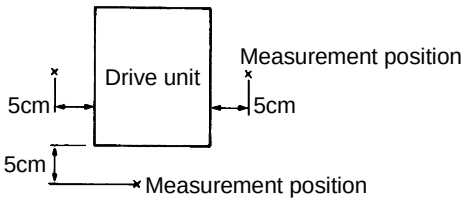
⚠ CAUTION
● **The drive unit itself can be the source of noises. Take noise suppression measures to prevent peripheral equipment from malfunctioning due to noises.** **Refer to: Chapter 3, 3.1.2 Noises** **Chapter 6, 6.3 Noise Malfunctions and Measures**

2.1.2 Installation in control box

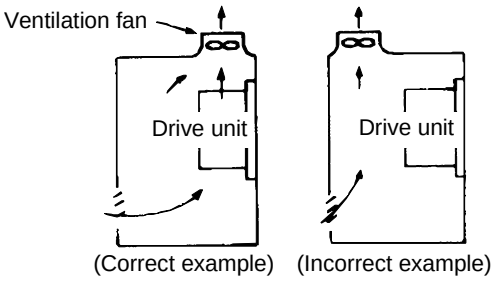
When installing the drive unit in a control box, the internal temperature of the control box must not exceed the permissible value due to drive-unit generated heat and peripheral-generated heat. Placing a heat sink outside the control box can reduce the heat generated inside the control box

Refer to: Chapter 7, 7.1.3 Option list (External heat sink mounting attachment)

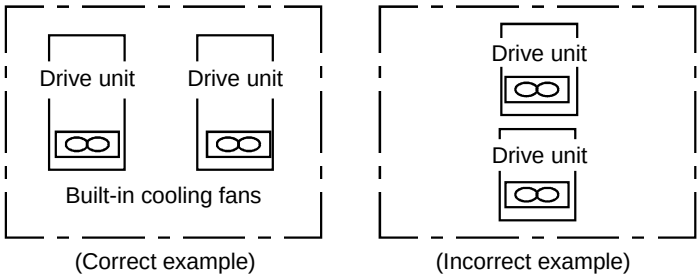
● Measurement positions of ambient temperatures



● Layout of drive units within control box



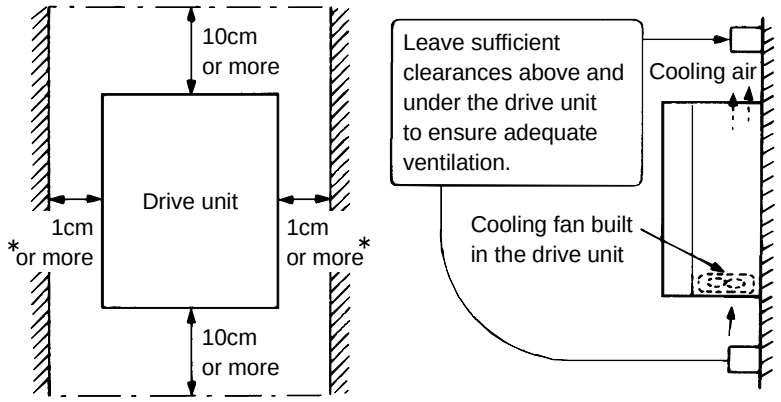
Position of ventilation fan



Accommodation of two or more drive units

NOTICE

● Leave the specified clearances between the drive unit and control box walls or other equipment. Not doing so can cause a failure. In addition, improper convection of air in the control box will reduce the heat dissipation effect. Fully consider the equipment layout in the control box and the use of a cooling fan for ventilation, for example.



* These clearances are also required for replacement of the cooling fan.

● Installation in enclosed control box

The following is the relationship between the internal temperature rise and heat dissipation area of an enclosed control box (hereafter referred to as the enclosure) which accommodates the drive unit.

$$A = \frac{P}{K \bullet \triangle T}$$

A: Heat dissipation area (m^2)
P: All losses produced in enclosure (W)
△T: Difference between enclosure inside and outside-air temperatures (°C)
K: Heat dissipation factor

The heat dissipation area A does not include the area in contact with a structures which interfere with heat dissipation, e.g. floor and walls.
The heat dissipation factor K used is normally 5 to 6, which depends on the enclosure structure, the layout of parts in the enclosure, and the outside-air temperature.

● Produced losses

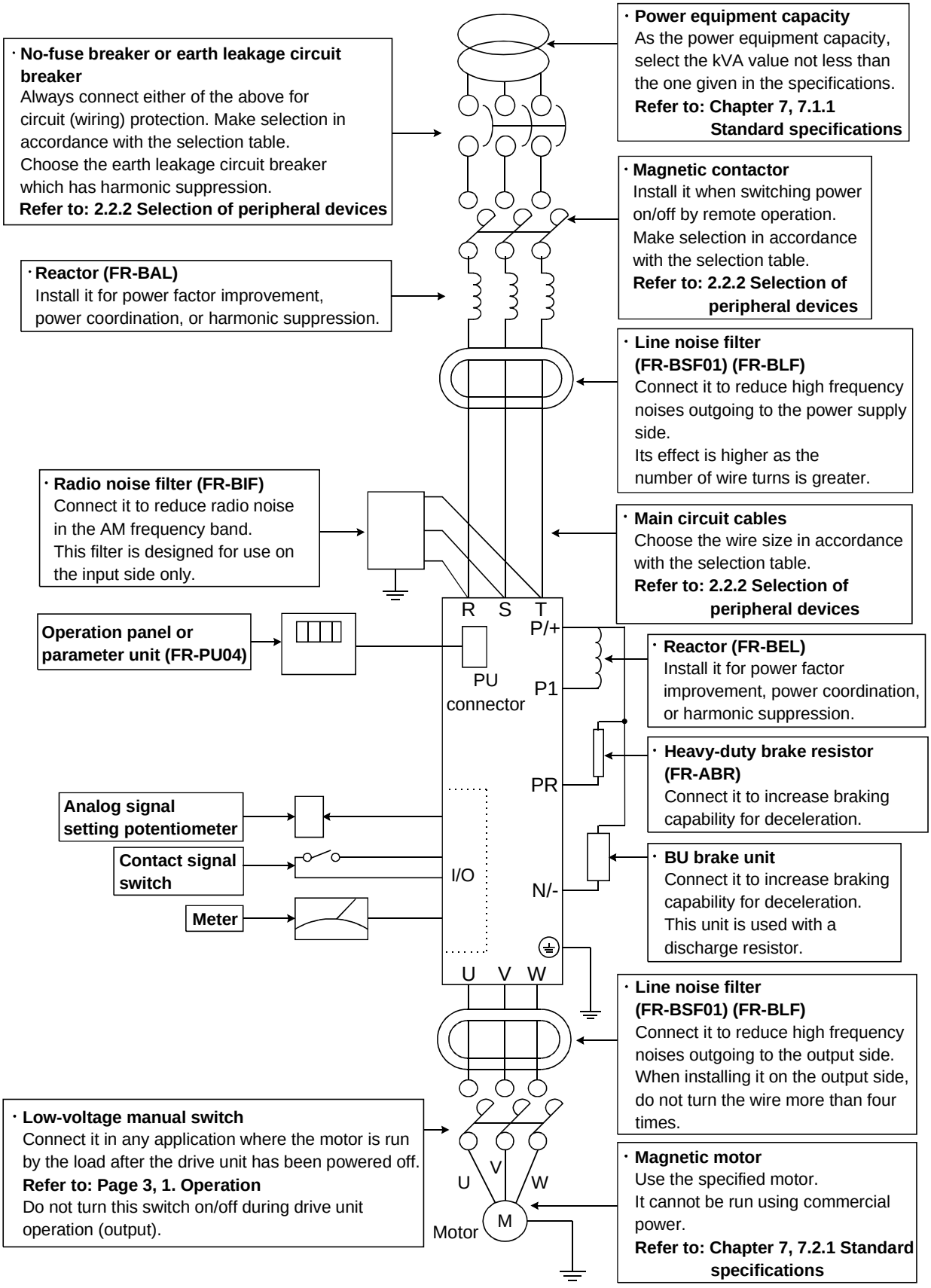
The following table indicates the losses produced during rated load operation of the drive unit.

Unit (W)

Capacity	**Drive Unit-Produced Loss during Continuous Rated Load Operation**	**Loss Produced in Enclosure when Drive Unit Heat Sink Is Placed Outside of Enclosure**
0.5K	55	—
1.0K	70	—
1.5K	110	33
2.0K	150	45
3.5K	230	69

2.2 Preparation of Peripheral Devices

2.2.1 Basic configuration



2.2.2 Selection of peripheral devices

(1) Wire size

● AC power input terminals R, S, T, motor connection terminals U, V, W, DC reactor connection terminals P/+, P1, DC terminals P/+, N/-, ground terminals

Capacity (K)	Terminal Screw Size	Wire Sizes, Unit: mm^2				Wire Type
		R, S, T	U, V, W	P/+, P1, N/-	Connection	
0.5	M4	2 to 5.5	2 to 5.5	2 to 5.5	2 to 5.5	Power cable 600V vinyl wire or equivalent
1.0						
1.5						
2.0						
3.5		3.5 to 5.5	3.5 to 5.5	3.5 to 5.5	3.5 to 5.5	

● Control circuit power supply terminals R1, S1

Capacity	Terminal Screw Size	Wire Size, Unit: mm^2	Wire Type
All capacities	M4	2 to 5.5	Power cable 600V vinyl wire or equivalent

● Control circuit terminals (all terminals)

Capacity	Terminal Screw Size	Wire Size, Unit: mm^2	Wire Type
All capacities	M3.5	0.5 to 2	Twisted shielded wire, polyethylene insulated vinyl wire for instrumentation or equivalent

MEMO	● Refer to the corresponding instruction manual for wires connection of a stand-alone option connected to the DC terminals P/+, N/-.

NOTICE	● Choose the size of the wires connected to the motor connection terminals so that a voltage drop due to the wires is less than 4V. The minimum wire size in the above selection table assumes that the wiring length is less than 20m. A voltage drop can be found by the following expression: Line voltage drop (mV) = $\sqrt{3} \times$ wire resistance (Ω/km) $\times$ wiring length (m) $\times$ current (A) ● Use the ground cable which is as thick as possible. ● We recommend you to use the 0.75mm^2 or less wire size for the control circuit terminals. Using the wire size of 1.25mm^2 or more may cause the front cover to bulge, leading to a contact fault in the operation panel or parameter unit, when there are many cables wired, for example.

(2) Crimping terminals

Wire Size, Unit: mm^2	Terminal Screw Size	Crimping Terminal Size
0.5	M3.5	1.25-3.5
0.75	M3.5	1.25-3.5
1.25	M3.5	1.25-3.5
2	M3.5	2-3.5
	M4	2-4
3.5/5.5	M4	5.5-4

(3) No-fuse breakers, magnetic contactors

Capacity (K)	No-Fuse Breaker		Magnetic Contactor
	With power factor improving reactor	Without power factor improving reactor	
0.5	30AF/5A		S-N10
1.0	30AF/10A		
1.5	30AF/15A		
2.0	30AF/15A	30AF/20A	S-N11, S-N12
3.5	30AF/30A		S-N20

(4) Earth leakage circuit breakers

● Selection method

Use the earth leakage circuit breaker which has harmonic/surge suppression.

Our product: Progressive Super Series NV-SF, NV-CF

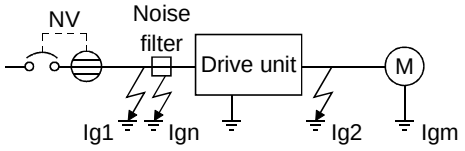
Capacity (K)	Earth Leakage Circuit Breaker	
	With power factor improving reactor	Without power factor improving reactor
0.5	30AF/5A	
1.0	30AF/10A	
1.5	30AF/15A	
2.0	30AF/15A	30AF/20A
3.5	30AF/30A	

MEMO	● Leakage currents from the wiring and motor include frequency components of a higher degrees than those from the commercial power supply. Therefore, the earth leakage circuit breaker which is not a harmonic/surge suppression product can cause unnecessary operations. <Measures against unnecessary operations> • Minimize the wiring distance of I/O cables. • Run I/O cables away (more than 30cm) from the earth. • Reduce the Pr. 72 "motor tone selection" setting.

● Setting of rated current sensitivity

Rated current sensitivity ≥ 10 {Ig1 + Ign + K (Ig2 + Igm)}

K: Constant in consideration of harmonics

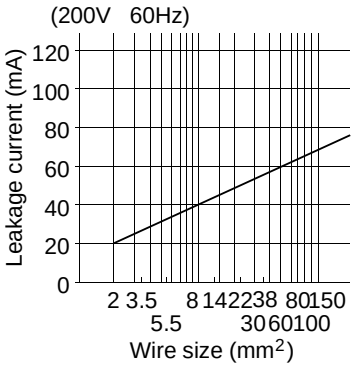


Earth Leakage Circuit Breaker		K
Type	Our product	
Harmonic/surge suppression product	NV-SF NV-CF	1
General product	NV-CA NV-CS NV-SS	3

Ig1: Leakage current in cable path between earth leakage circuit breaker and drive unit (see Fig. 2-2)

Ig2: Leakage current in cable path between drive unit and motor (see Fig. 2-2)

Fig. 2-2 Example of Leakage Current per 1km of Cable Path
When CV Cable Is Routed in Metal Conduit



Ign: Leakage current of filter connected on input side

Refer to Chapter 7, 7.1.3 Option list for our dedicated filters.

Igm: Leakage current of motor

Capacity (K)	Leakage Current (mA)
0.5, 1.0	0.1
1.5, 2.0	0.2
3.5	0.3

NOTICE	● Install the leakage current circuit breaker on the input side (power supply side) of the drive unit. Installation on the output side will cause the earth leakage circuit breaker to overheat or malfunction.

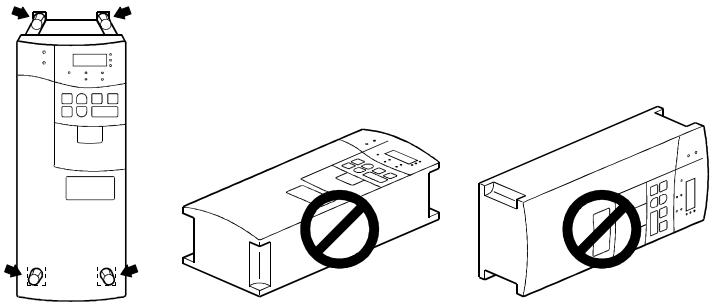
MEMO	● A leakage current may flow into the other lines through the ground cables, etc.

2.3 Installation Method

1) Remove the front cover.
2) Pass screws or bolts into the four mounting holes and secure the drive unit.
3) Replace the removed cover. Leave the cover removed when continuing the wiring work.

⚠ CAUTION

- **Prevent screws, metal pieces and other conductive foreign matter and oil and other flammable foreign matter from entering the drive unit.**
- **Securely screw or bolt the unit to the mounting surface vertically without looseness. Always install the unit in the specified mounting orientation. Not doing so can cause a failure.**



- **Do not drop the unit, or subject it to impact.**

NOTICE	● Fully check that the front cover has been mounted securely. Insecure mounting can cause a drop due to vibration or a display fault of the operation panel. ● The front cover is fitted with the capacity plate and the drive unit with the name plate. The same serial number is printed on these plates. Always reinstall the cover to the drive unit from where it had been removed.

3. WIRING

This chapter describes the wiring of the drive unit.

⚠ WARNING

- **Any person who is involved in the wiring of this equipment should be fully competent to do the work. Otherwise, an electric shock or fire can occur.**
- **Always install the unit before wiring. Otherwise, an electric shock or fire can occur.**
- **Before restarting wiring after switching power "ON", make sure that the motor is at a stop, wait for more than 10 minutes after switching power "OFF", and confirm that the DC voltage across the DC terminals P/+ and N/- is low enough to do wiring. Immediately after power "OFF", the DC terminals P/+, N/- are charged with more than 200V (residual voltage of the internal capacitor). Therefore, an electric shock may occur.**
- **Even after power-off, the motor connection terminals U, V, W have high voltages while the motor is running. Always start wiring after confirming that the motor has stopped. Not doing so can cause an electric shock.**

⚠ CAUTION

- **Take measures to prevent peripheral sensors and equipment from malfunctioning due to electromagnetic noises. Not doing so can cause accidents.**
- **Take measures to prevent peripheral power capacitors and generators from overheating or being damaged due to power harmonics. Not doing so can cause a fire.**
- **Do not leave wire offcuts in the drive unit. Doing so can cause a fault, failure or malfunction.**
- **If the machine must not be restarted when power is restored after a power failure, provide a magnetic contactor on the power supply side and also make up a sequence which will not turn "ON" the start signal automatically when power is restored.**
- **Tighten the terminal screws to the specified torque. Undertightening can cause an inter-terminal short circuit or malfunction. Overtightening can cause the screws and unit to be damaged, resulting in a short circuit, malfunction or the like.**
- **When using the unit having a built-in brake resistor or using the brake resistor (option), switch power off with the alarm signal of the unit. If you do not so, a brake transistor failure or like may overheat the brake resistor abnormally, causing a fire.**

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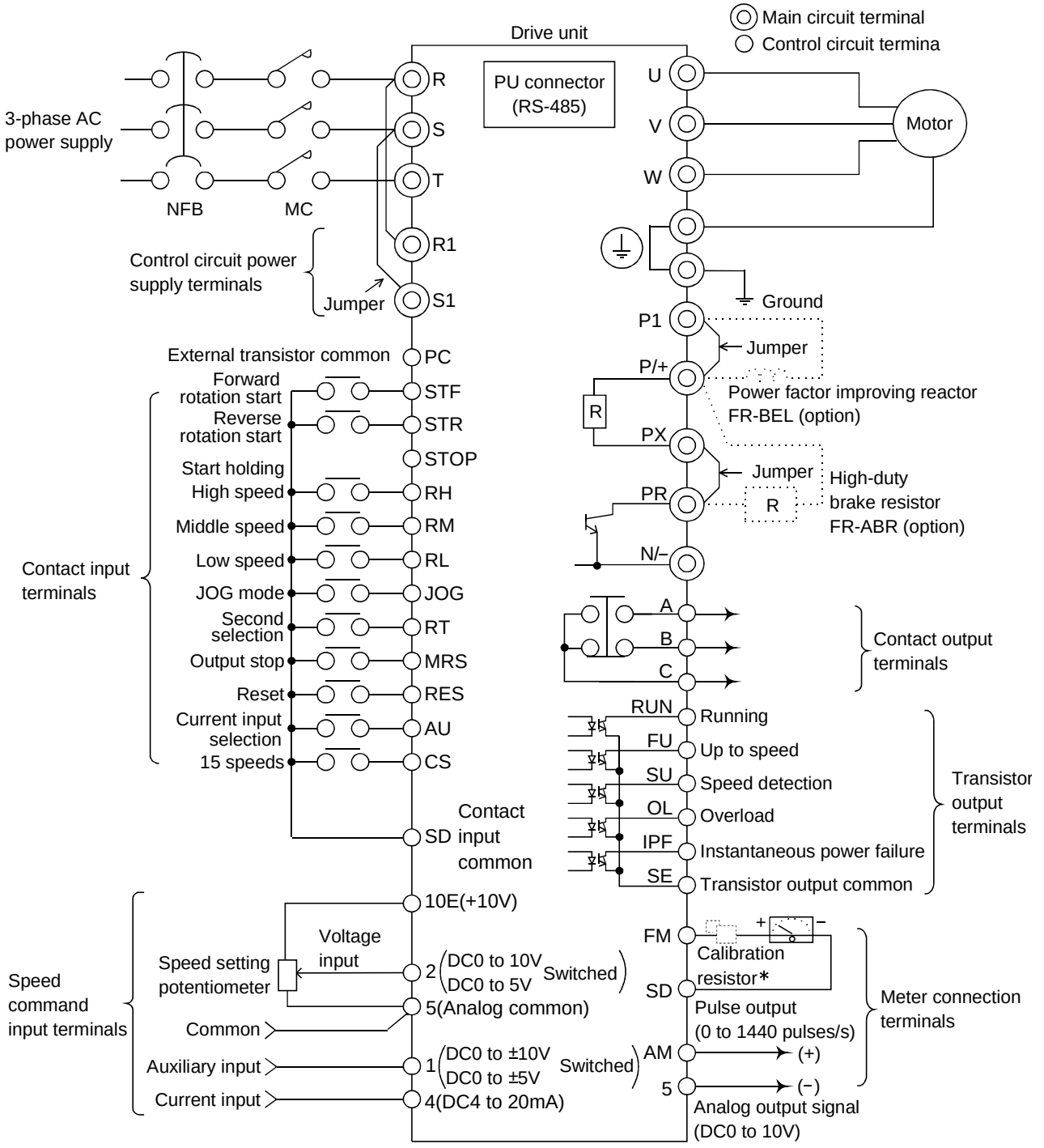
3.1 Pre-Wiring Instructions

3.1.1 Terminal connection diagram

The following shows the wiring of all terminals (when sink logic is used). After confirming the function of each terminal, wire necessary terminals according to your application. When the operation panel is used to perform operation, merely doing the main circuit wiring enables the motor to run.



*This resistor is not needed when you use the operation panel (FR-DU04) or parameter unit (FR-PU04) to make calibration. This resistor is used when you need to calibrate the meter nearby because the meter is at a remote location, for example. Note that when you connect the calibration resistor, the meter may not deflect to the full scale. In this case, use the operation panel or parameter unit with the resistor to make calibration.

3.1.2 Noises

Take the following measures if you want to further suppress noises which affect the drive unit or when there are devices nearby which are susceptible to noises (e.g. measuring instruments, telephone lines, various sensors).

(1) When noises are expected from the drive unit signal cables

- Fit data line filters to the signal cables.

(2) When there are devices nearby which are connected to the power supply whose line is different from that of the drive unit

- Run the signal cables of the device as far away as possible from the drive unit and its power cable.
- Avoid the parallel wiring and bundling of the device's signal cables and the drive unit's power cable.
- Connect a line noise filter to the input or output side of the drive unit's power cable.
- Connect a radio noise filter to the input side of the drive unit's power cable.
- Use shielded cables as the signal and power cables.
- Run the signal and power cables in separate metal conduits.

(3) When there are devices which are connected to the power supply whose line is the same as that of the drive unit

- Connect a line noise filter to the input or output side of the drive unit's power cable.
- Connect a radio noise filter to the input side of the drive unit's power cable.

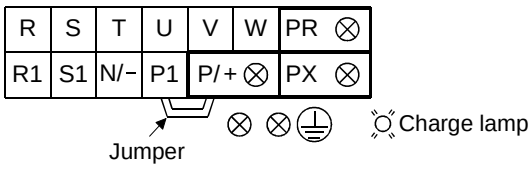
NOTICE	● The effects of the above noise suppression techniques depend on the propagation paths of noises and the noise immunities of the devices. **Refer to: Chapter 6, 6.3 Noise Malfunctions and Measures**

3.2 Wiring of the Main Circuit Terminals

3.2.1 Terminals

Symbols	Name	Description
R, S, T	AC power input terminals	Connect to the commercial power supply.
U, V, W	Motor connection terminals	Connect to a dedicated variable-speed synchronous motor.
R1, S1	Control circuit power supply terminals	Connected to the AC power input terminals R, S. To retain the alarm display and alarm output, remove the jumpers from the terminal block (across R-R1 and S-S1) and input external power to these terminals.
P/+, PR	Brake resistor connection terminals	Disconnect the jumper from terminals PR-PX and connect the FR-ABR brake resistor (option).
P/+, P1	DC reactor connection terminals	Disconnect the jumper from terminals P/+-P1 and connect the FR-BEL power factor improving DC reactor (option).
P/+, N/-	DC terminals	Connect to the BU brake unit (option) or FR-HC high power factor converter (option).
PR, PX	Built-in brake circuit connection terminals	When the jumper is connected across terminals PX-PR (factory setting), the built-in brake circuit is enabled.
⏚	Ground terminals	Terminals for connection of the ground cables. (There are two terminals.)

3.2.2 Terminal layout and connection specifications

<table>
<tr><th colspan="2">AX520-0.5, 1.0K</th><th colspan="2">AX520-1.5K to 3.5K</th></tr>
<tr><td colspan="2">Layout
 
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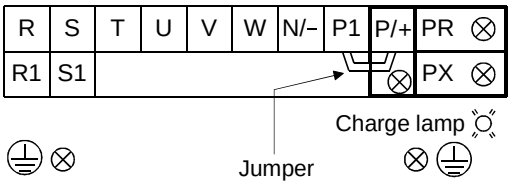
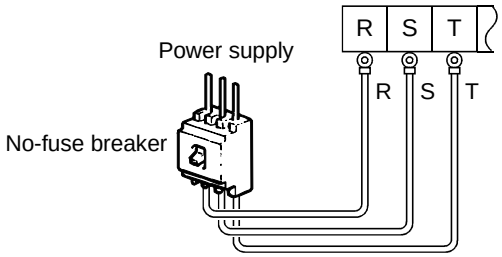
 
</td></tr>
<tr><td>Screw size
M4</td><td>Tightening torque
1.5N•m</td><td>Screw size
M4</td><td>Tightening torque
1.5N•m</td></tr>
</table>

⚠ CAUTION

- **Tighten the terminal screws to the specified torque. Undertightening can cause an inter-terminal short circuit or malfunction. Overtightening can cause the screws and unit to be damaged, resulting in a short circuit malfunction or the like.**

3.2.3 Wiring of the AC power input terminals R, S, T

Connect these terminals to the AC power supply. You need not match the phase sequence.

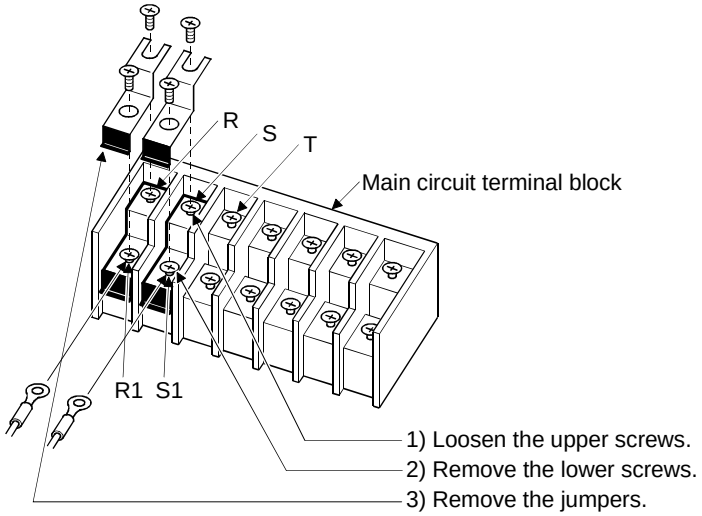


⚠ CAUTION
● **Always apply power to only the AC power input terminals R, S, T and control circuit power supply terminals R1, S1. Applying power to the other terminals will damage the unit.**

3.2.4 Wiring of the control circuit power supply terminals R1, S1

Wire these terminals when you want to supply the control circuit power of the drive unit to retain the alarm signal if the magnetic contactor (MC) on the power supply side is opened to switch off main circuit power when the protective circuit is activated.

1) Remove the jumpers across the terminals R-R1, S-S1.
2) Wire the terminals R1, S1 from the primary side of the magnetic contactor.

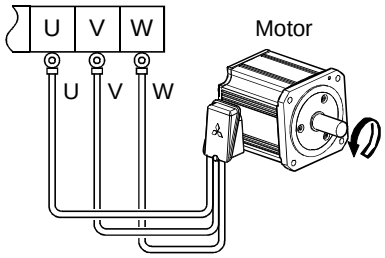


MEMO	● An error display (E.OC1) will be provided if you turn on the start signal with power supplied to only the R1 and S1 terminals.

⚠ CAUTION
● **When you have energized the AC power input terminals R, S, T, always energize the control circuit power supply terminals R1, S1, too. The drive unit may be damaged if you energize the AC power input terminals without the control circuit power supply terminals being energized.**
● **Before wiring the control circuit power supply terminals, always remove the jumpers across the terminals R-R1 and across the terminals S-S1. Not doing so can cause a power supply short circuit.**

3.2.5 Wiring of the motor connection terminals U, V, W

Connect these terminals to the motor. Match the phase sequence of the motor connection terminals U, V, W with that of the motor cables. Incorrect phase sequence will run the motor in reverse.

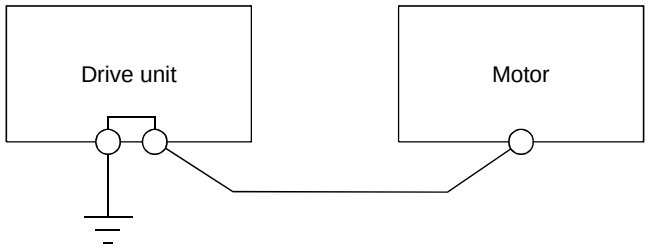


⚠ CAUTION

- **The wiring length between the drive unit and motor should be 100m maximum. Long wiring may cause torque to be insufficient or the overcurrent protection function to be activated.**
- **Between the drive unit and motor, do not fit a power capacitor, surge suppressor or FR-BIF radio noise filter (option).**

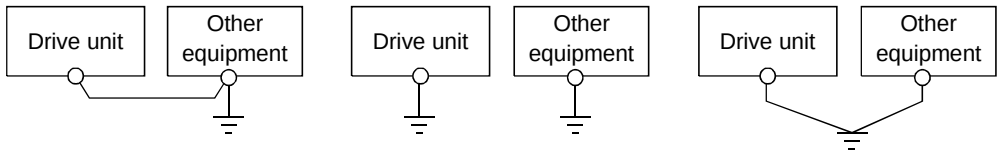
3.2.6 Wiring of the ground terminals ⏚

There are two ground terminals. Connect one ground terminal to the motor's ground terminal and perform shared grounding on the drive unit.



NOTICE

- Avoid shared grounding with the other equipment susceptible to noise, and perform exclusive or single-point grounding.

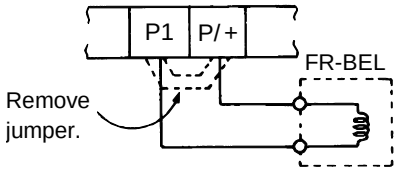


⚠ WARNING

- **Ground the drive unit and motor securely to prevent an electric shock due to leakage currents. (Class D grounding, grounding resistance 100Ω max.)**
- **For grounding, connect the cable to the exclusive ground terminal. (Do not use the screw of the casing, chassis or the like.)**

3.2.7 Wiring of the DC reactor connection terminals P/+, P1

These terminals are designed for connection of the power factor improving reactor (FR-BEL). Remove the jumper across the terminals P/+-P1 and connect the DC reactor.



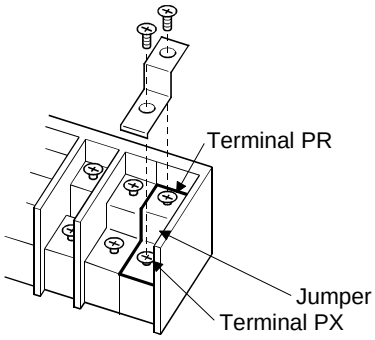
NOTICE	● The wiring distance (overall length) should be within 5m.

MEMO	● Without removal of the jumper, the reactor will not be active.

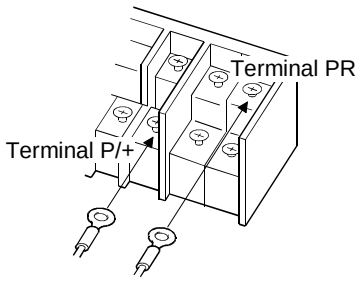
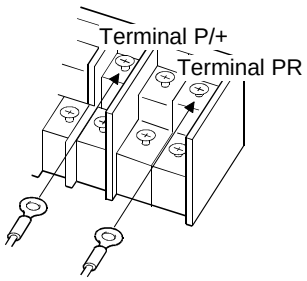
3.2.8 Wiring of the brake resistor connection terminals P/+, PR

These terminals are designed for connection of the heavy-duty brake resistor.

1) Remove the screws in the terminals PR and PX and disconnect the jumper.



2) Connect the brake resistor to the terminals P/+, PR.

FR-AX520-0.5K, 1.0K	FR-AX520-1.5K to 3.5K
	

3) Change the Pr. 30 and Pr. 70 settings.

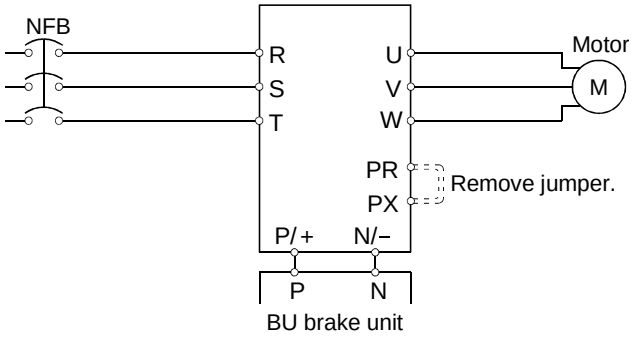
NOTICE	● Always remove the jumper across the terminals PR-PX. ● Connect only the specified brake resistor.

3.2.9 Wiring of the DC terminals P/+, N/-

These terminals are designed for connection of the BU brake unit or high power factor converter.

● For connection of BU brake unit

1) Remove the jumper across the terminals PR-PX.
2) Connect the BU brake unit. For full information, read the BU brake unit instruction manual.
3) Change the Pr. 30 setting.

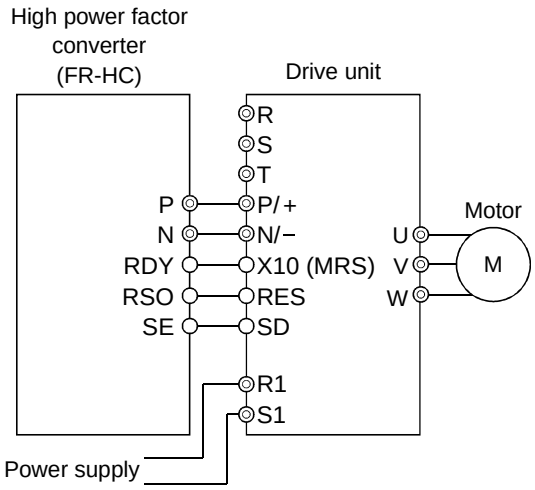


⚠ CAUTION

- **Do not connect the brake resistor or the like to the DC terminals P/+, N/- directly. Doing so can cause a fire.**
- **Incorrect (opposite) connection to the DC terminals P/+, N/- will damage the drive unit.**

● For connection of high power factor converter (FR-HC)

1) Connect the control circuit power supply terminals R1, S1 to the power supply.
   Refer to: 3.2.4 Wiring of the control circuit power supply terminals R1, S1
   Do not connect the AC power input terminals R, S, T of the drive unit.
2) Select sink logic (factory setting) as the control logic of the control circuit contact input terminals.
   The converter cannot use source logic.
   Refer to: 3.3.3 Switching between sink logic and source logic
3) Assign the X10 signal to the control circuit contact input terminal of the drive unit.
   Refer to: Chapter 8, 8.4 Selection of the Control Circuit Contact Input Terminal Functions
4) Connect the high power factor converter. For details, refer to the high power factor converter instruction manual.
5) Change the Pr. 30 setting.



⚠ CAUTION

- **Do not connect a power supply to the AC power input terminals R, S, T of the drive unit. Doing so will damage the drive unit.**
- **Opposite polarity (reverse connection) of the DC terminals P/+, N/- will damage the drive unit.**

3.3 Wiring of the Control Circuit Terminals

⚠ CAUTION

● **Use shielded or twisted cables for wiring the control circuit input terminals. Also run them away from the main circuit wiring and other power cables. Not doing so can cause a malfunction due to noise.**

3.3.1 Terminals

After confirming the function of each terminal, use necessary terminals according to your application.

(1) Contact input terminals

● Turning the signal across any terminal and common terminal "ON" (closing those terminals)/"OFF" (opening those terminals) provides the corresponding function as described below.

● The shaded terminal symbols indicate that their functions can be changed.

Refer to: Chapter 8, 8.4 Selection of the Control Circuit Contact Input Terminal Functions

Symbol	Name	Description	
STF	Forward rotation start	Turn on this signal to start forward rotation or turn it off to stop.	Simultaneously turning on these signals gives a stop command.
STR	Reverse rotation start	Turn on this signal to start reverse rotation or turn it off to stop.	
STOP	Start holding	Used to self-hold the start signal.	
RES	Reset	Turn on this signal (for more than 0.1s) to reset the protective circuit activated. Turn it off after the protective circuit is reset.	
MRS	Output stop	Turn on this signal (for more than 0.1s) to stop the output and separate the motor electrically, causing it to coast. Turing it off with the start signal input will restart the motor at the starting speed.	
RH	High speed	Combine on/off of these signals as appropriate to select multiple speeds. **Refer to: Chapter 8, 8.3.2 Variable-speed operation using contact input signals**	
RM	Middle speed		
RL	Low speed		
CS	15 speeds		
JOG	JOG mode	Turn on this signal to start jog operation.	
RT	Second selection	Turn on this signal to select the second acceleration/deceleration time.	
AU	Current input selection	Turn on this signal to choose the speed command of the terminal 4 (current input), enabling operation using the 4 to 20mA current signal.	
SD	Contact input common	Common to the contact input terminals. (When sink logic is used)	
PC	External transistor common	Common terminal used when the contact input terminal is connected to the transistor output (open collector output) of the external controller. This terminal can prevent a malfunction caused by a sneak current.	
		This terminal acts as a common terminal when the contact input terminal uses source logic.	

MEMO	● Ratings of the contact input terminals Input resistance: 4.7kΩ, open-time voltage: 24±3VDC, short circuit-time current: 4 to 6mADC ● Use the terminal PC as a power supply terminal. Can be used as a power supply for a sensor or equivalent. The common terminal is the terminal SD (digital common). Power supply voltage range: 24±2VDC, max. permissible current: 100mA When the terminal is used as a power supply, it cannot be used as an external transistor common terminal to prevent a sneak current. ● The response time of the contact input terminal is 20ms±15ms. (When the stall prevention function is activated, response may be slower.)

NOTICE	● When a transistor is used to input the signal of the contact input terminal, make sure that the electrical characteristics of the transistor used satisfy the following: I_C: Collector current, 10mA or more V_{CEX}: Open-time collector-emitter permissible voltage, 30V or more $V_{CE(sat)}$: Conduction-time collector-emitter saturation voltage, 3V or less I_{CEX}: Collector shutoff current (leakage current), 100uA or less ● When a relay contact is used to input the signal of the contact input terminal, use two faint signal contacts in parallel or use a twin contact to prevent a contact fault.

(2) Speed command input terminals

● Terminals used to vary the motor speed with analog signals.

● The parameter function allows you to choose the analog speed command specifications.

Refer to: Chapter 8, 8.3.1 Selection of the analog speed command specifications

Symbol	Name	Rating	Description
2	Voltage input	Input resistance: 10±1kΩ Max. permissible voltage: 20VDC	You can perform operation at the speed proportional to a 0 to 10VDC (or 0 to 5VDC) voltage signal.
4	Current input	Input resistance 250Ω±2% Max. permissible current: 30mADC	You can perform operation at the speed proportional to a 4 to 20mADC current signal.
1	Auxiliary input	Input resistance: 10±1kΩ Max. permissible voltage: ±20VDC	You can perform operation at the speed proportional to a 0 to ±10VDC (or 0 to ±5VDC) voltage signal plus the speed command value of terminal 2 or 4.
5	Analog common	—	Common to the speed command input terminals. Do not earth.
10	Power supply 5V	5V±0.2VDC Permissible load current: 10mA	Can be used as a power supply for the analog input signal, e.g. speed setting potentiometer. The common terminal is terminal 5 (analog common).
10E	Power supply 10V	10V±0.4VDC Permissible load current: 10mA	

(3) Transistor output terminals

● When the function of any terminal is activated, the internal transistor (open collector output) connected across that terminal and common terminal turns ON (conducts).

● You can set the parameter function to change the function of each terminal.

Refer to: Chapter 8, 8.7.2 Selection of the control circuit output terminal functions
Chapter 8, 8.7.3 Detection of running speed

Symbol	Name	Description
RUN	Running	ON (conducts) while the drive unit is outputting a speed command to the motor. OFF (does not conduct) during voltage braking operation, stop, or coasting.
FU	Speed detection	Turns ON (conducts) when the speed output by the drive unit reaches or exceeds the preset value. OFF (does not conduct) when the speed is less than that.
SU	Up to speed	Turns ON (conducts) when the speed output by the drive unit reaches the preset value. OFF (does not conduct) when the speed is less than the preset value.
OL	Overload alarm	Turns ON (conducts) when stall prevention is activated. OFF (does not conduct) when stall prevention is deactivated. (Minimum width of ON-time output signal: 100ms) **Refer to : Pr. 22 [Section 8.5.6]**
IPF	Instantaneous power failure	Turns ON (conducts) when instantaneous power failure or undervoltage protection is activated.
SE	Transistor output common	Common to the transistor output terminals. Isolated from the terminals SD, 5.

MEMO	● Ratings of transistor output terminals Max. permissible voltage: 27VDC, max. permissible current: 0.1ADC

NOTICE	● When driving a coil load, connect a diode. **Refer to: 3.3.6 Wiring of the transistor output terminals**

(4) Contact output terminals

● When the protective function is activated, the relay contact connected to the terminal opens/closes

Refer to: Chapter 6, 6.1.1 Protective function activated

● You can set the parameter function to change the function of each terminal.

Refer to: Chapter 8, 8.7.2 Selection of the control circuit output terminal functions

Symbol	Contact Capacity	Description
A, B, C	200VAC 0.3A or 30VDC 0.3A	Normal : Terminals B-C closed (Terminals A-C open) Protective function activated: Terminals B-C open (Terminals A-C closed)

MEMO	● The response time of the contact output terminals is less than 100ms. (After drive unit output shutoff) ● When the drive unit is powered off, the contact output is placed in a normal status. Therefore, the contact output signal is not held when power is switched off after the protective function has been activated. When the signal must be held, provide an external holding circuit or use the control circuit power supply terminals R1, S1.

(5) Instrument connection terminals

● Used to display the motor speed externally.

● You can use the parameter function to choose the item other than the motor speed

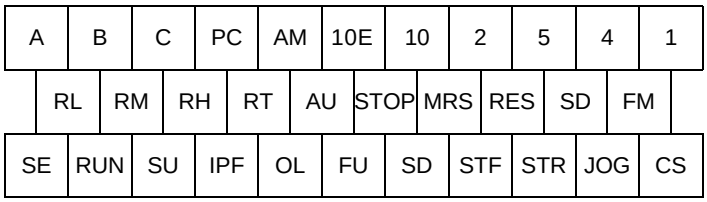
Refer to: Chapter 8, 8.7.5 Selection of the instrument connection terminal functions

Symbol	Name	Description
FM	Meter connection	The output voltage has an 8VDC pulse waveform. The output varies in proportion to the motor speed and the average voltage is preset to approx. 4.7V at the rated speed and 1440 pulses/s. As a meter, use a 1mA moving-coil type DC ammeter or digital counter. As the common terminal, use terminal SD (digital common).
AM	Analog signal output	The output varies in proportion to the motor speed and is preset to 10VDC at the rated speed. The common terminal is terminal 5 (analog common).

MEMO	● The output signals from the terminals FM and AM are updated at intervals of several 10 ms.

3.3.2 Terminal layout and connection specifications

Layout



Screw size	Tightening torque
M3.5	1.2N•m

3.3.3 Switching between sink logic and source logic

Description

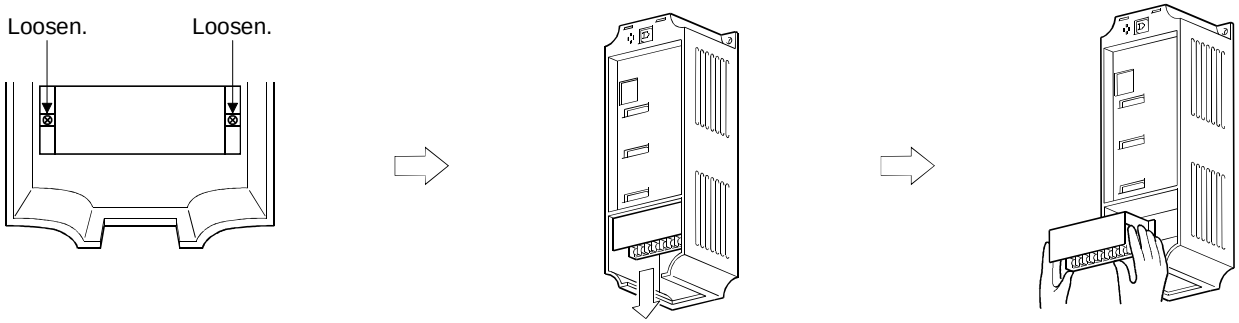
Sink Logic	Source Logic
In this logic, a signal turns ON when a current flows out of the input terminal.	In this logic, a signal turns ON when a current flows into the input terminal.

To use the contact input terminals as source logic, the connector on the back of the control circuit terminal block must be moved to the other position. The control logic is factory-set to sink logic.

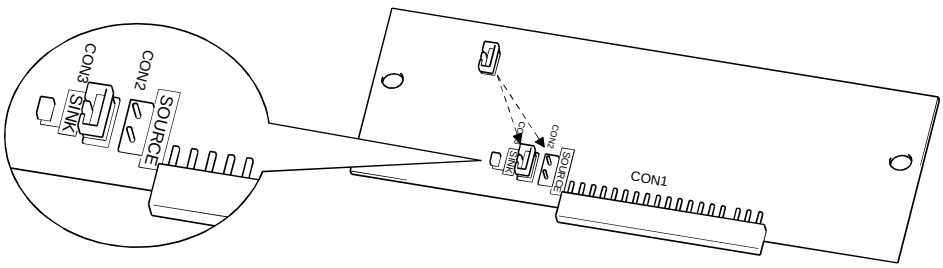
MEMO	● You need not change the connector position when using only the transistor output terminals as source logic.

● To use the terminals as source logic, change the setting in the following procedure.

1) Loosen the two mounting screws on both ends of the control circuit terminal block. (The screws cannot be removed.)
2) With both hands, pull down the terminal block from the back of the control circuit terminals.



3) Change the connector position on the back of the terminal block from "SINK" to "SOURCE".



4) Reinstall the control circuit terminal block in the original position and fix it with the screws.

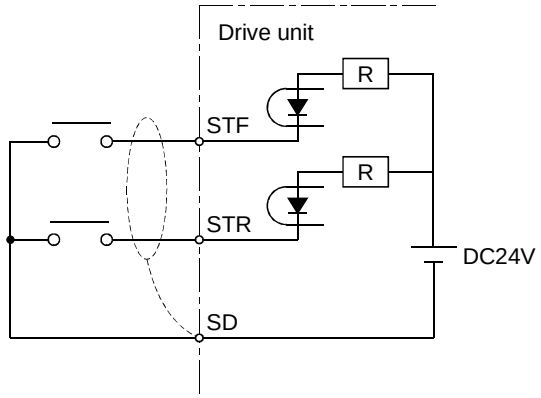
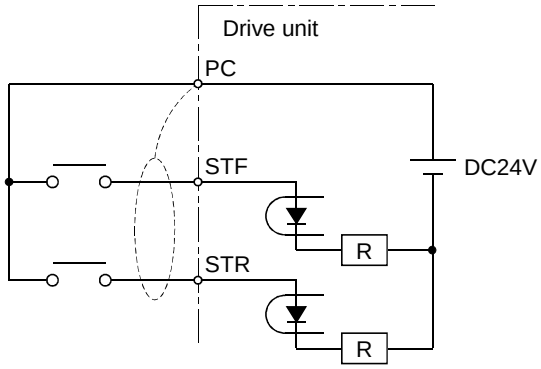
NOTICE	● While power is on, never disconnect the control circuit terminal block. ● Check the control circuit connector CON1 to ensure that the pins are fitted properly without bending. ● Make sure that the logic changing connector is inserted correctly. ● The logic changing connector is a small component. Handle it with care when changing the logic. ● The logic changing connector must be fitted in only one of the above positions. Fitting it in both positions at the same time can cause a failure.

3.3.4 Wiring of the contact input terminals

Use shielded or twisted shielded cables for wiring. Connect one shield sheath to the common terminal of the corresponding logic connection. Leave the other shield sheath open.

● When using contact signals

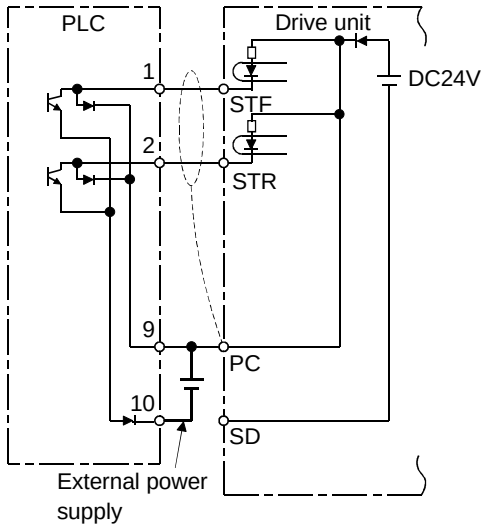
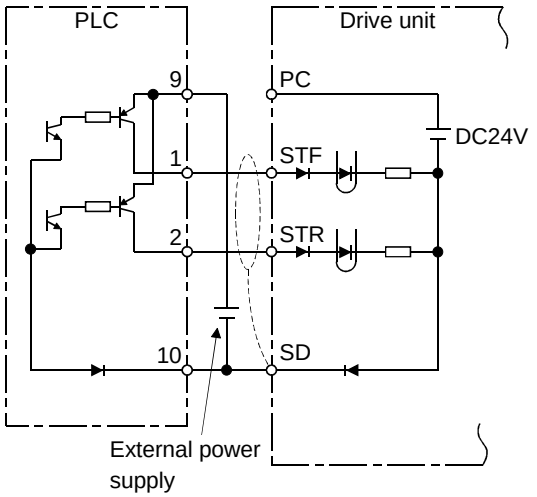
The following shows the wiring of the terminals STF, STR. The same wiring also applies to the other terminals.

Sink Logic	Source Logic
The terminal SD is a common terminal. 	The terminal PC is a common terminal. 

● When using non-contact switches

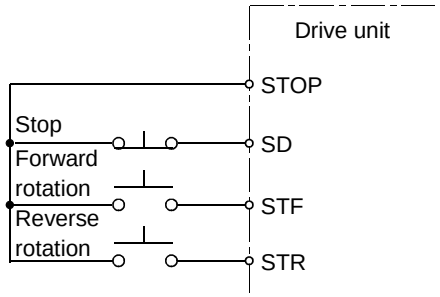
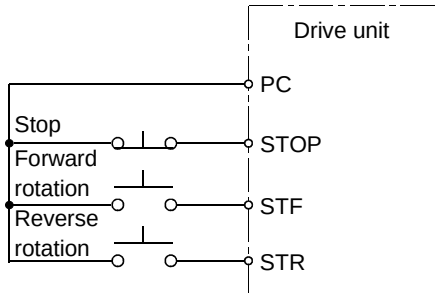
When using transistor outputs having an external power supply, such as a PLC, to input signals, perform the following wiring to prevent a malfunction caused by a sneak current from the external power supply.

The following shows the wiring of the terminals STF, STR. The same wiring also applies to the other terminals.

Sink Logic	Source Logic
The terminal PC is a common terminal. 	The terminal SD is a common terminal. 

● When using pushbuttons

Using the STOP terminal allows the start signal (forward/reverse rotation) to be self-held. When the start signal is input once, it is held within the drive unit until the stop signal is input. This function is not available for other than the start signal.

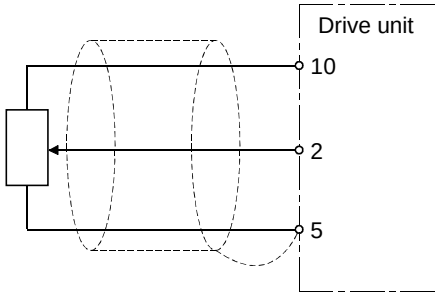
Sink Logic	Source Logic
The terminal SD is a common terminal. 	The terminal PC is a common terminal. 

NOTICE	● Do not apply voltages to the contact input terminals. ● Do not short the terminals PC and SD. Doing so will damage the unit. ● When the terminal PC is used as a power supply terminal, the wiring length should be within 30m.

3.3.5 Wiring of the speed command input terminals

Use shielded or twisted shielded cables for wiring. Connect one shield sheath to the terminal 5. Leave the other shield sheath open.

The same wiring also applies to the other terminals.

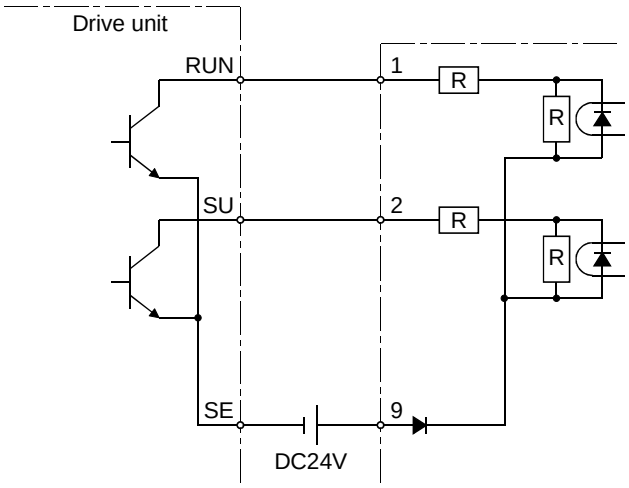


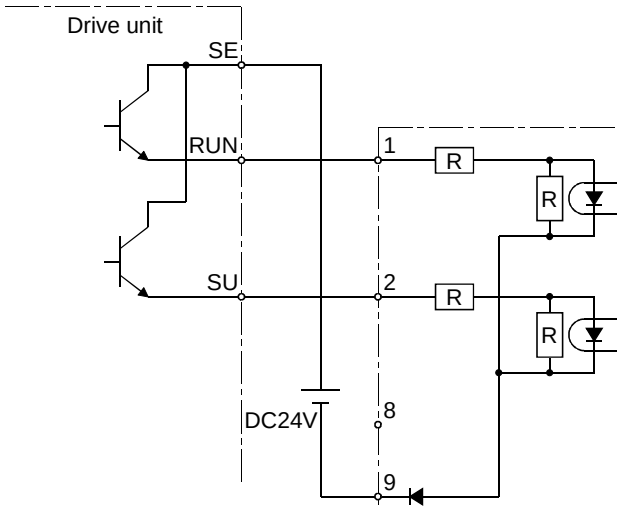
MEMO	● When using the voltage input of the terminal 2, select the power supply terminal (terminal 10 or 10E) which matches the voltage input value (as set in Pr. 73 [Section 8.3.1]) and make connection.

3.3.6 Wiring of the transistor output terminals

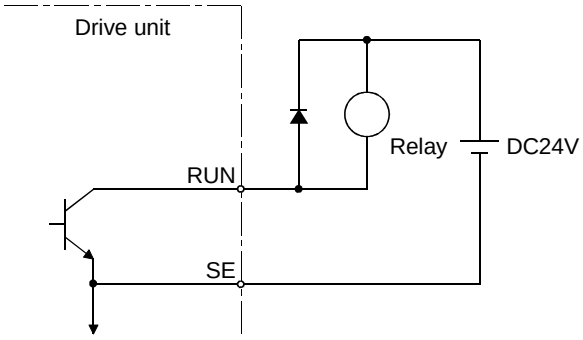
The following shows the wiring of the terminals RUN, SU. The same wiring also applies to the other terminals.

Sink Logic	Source Logic
The terminal SE is a common terminal.	The terminal SE is a common terminal.





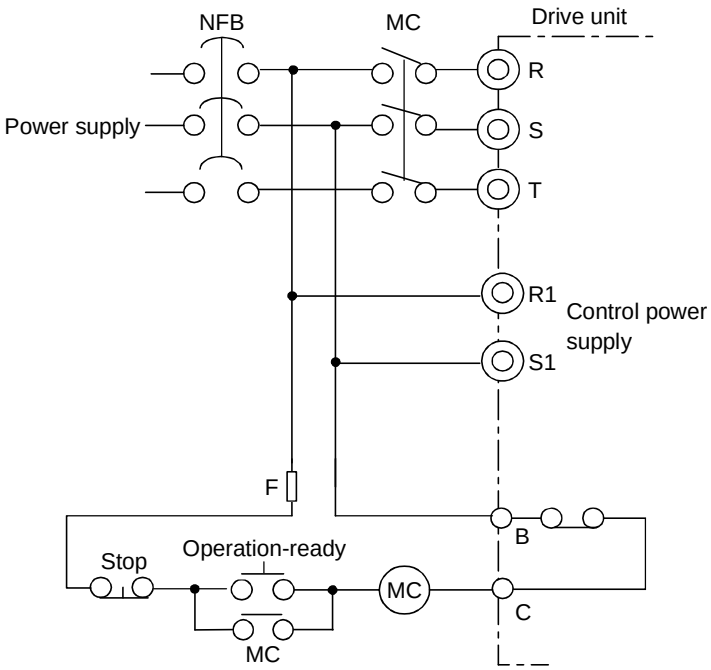
When driving a coil load such as a relay coil, always connect the following diode. Connect the diode with correct polarity. Opposite polarity will cause the drive unit to fail.



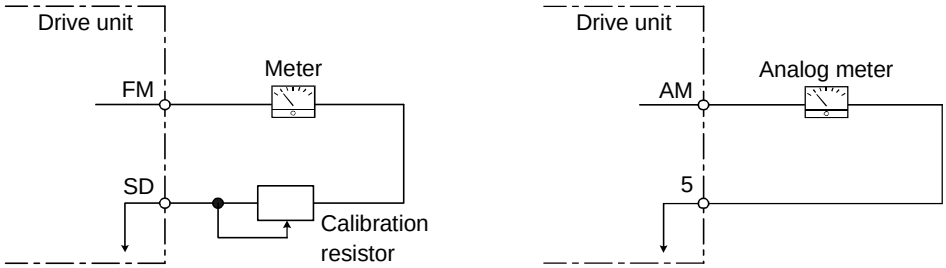
NOTICE	● The terminals SD, SE and 5 are isolated from each other. Do not connect them each other.

3.3.7 Wiring of the contact output terminals

The following wiring example assumes that when the protective circuit is activated, the magnetic contactor (MC) on the power supply side is opened to switch off the main circuit power and the control circuit power of the drive unit is supplied to hold the alarm signal.



3.3.8 Wiring of the instrument connection terminals

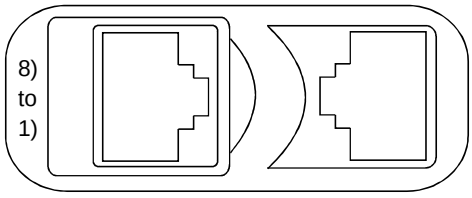


MEMO	● The calibration resistor is not needed when the operation panel or parameter unit is used to make calibration. **Refer to: Pr. 900, Pr. 901 [Section 8.7.5]** ● When using a shielded cable to wire the terminal AM, connect one shield sheath to the terminal 5. Leave the other shield sheath open. ● The wiring distance between the drive unit and meter should be as follows. Terminal FM: Within 200m (analog meter), within 50m (digital meter) Terminal AM: Within 30m ● For the terminal FM, you can connect up to two analog meters in parallel. ● For the output signal waveform of the terminal FM, refer to 6.4.5 Measurement of the circuit current.

3.4 Wiring of the PU Connector

3.4.1 Pin layout

As seen from the drive unit (receptacle side) front



1) SG 5) SDA
2) P5S 6) RDB
3) RDA 7) SG
4) SDB 8) P5S

NOTICE	● Pins No. 2 and 8 (P5S) provide power to the operation panel. Do not use them when making RS-485 communication.

3.4.2 Using the cable to connect the operation panel

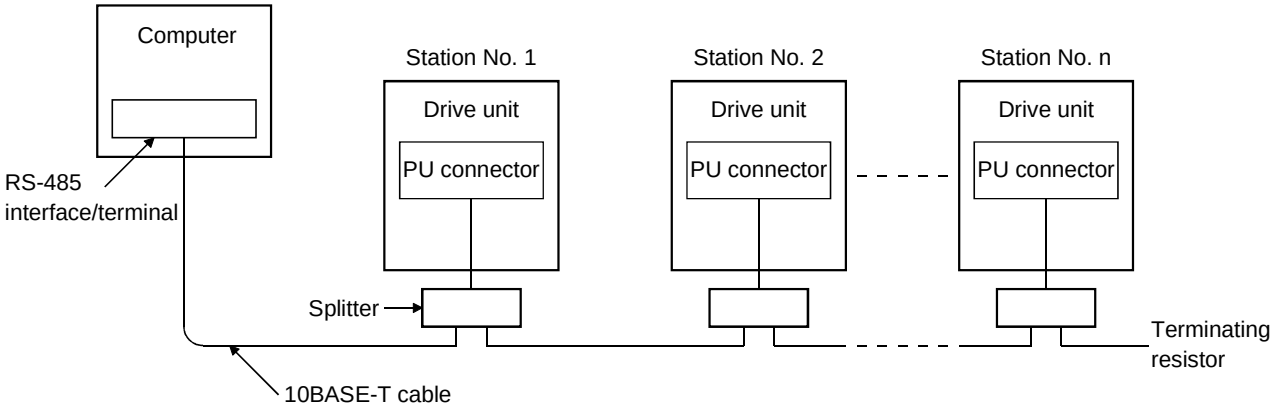
Use the optional "FR-CB2 parameter unit connection cable" or commercially available connector and cable for wiring.

Connector	RJ45 connector Example: 5-554720-3, Tyco Electronics Corporation
Cable	Cable conforming to EIA568 (such as 10BASE-T cable) Example: SGLPEV 0.5mm × 4P (Twiced pair cable, 4 pairs), Mitsubishi Cable Industries, Ltd.

NOTICE	● The maximum wiring length is 20m.

3.4.3 System configuration examples for communication operations

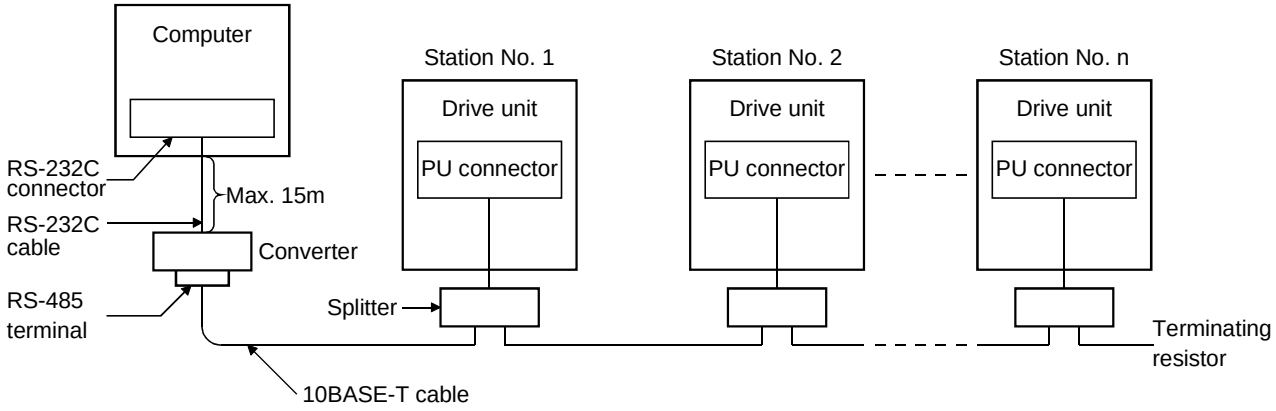
1) For RS-485 communication operation



● Parts used (Use commercially available parts for wiring)

Connector	RJ45 connector Example: 5-554720-3, Tyco Electronics Corporation
Cable	Cable conforming to EIA568 (such as 10BASE-T cable) Example: SGLPEV 0.5mm × 4P (Twisted pair cable, 4 pairs), Mitsubishi Cable Industries, Ltd.

2) For RS-232C communication operation



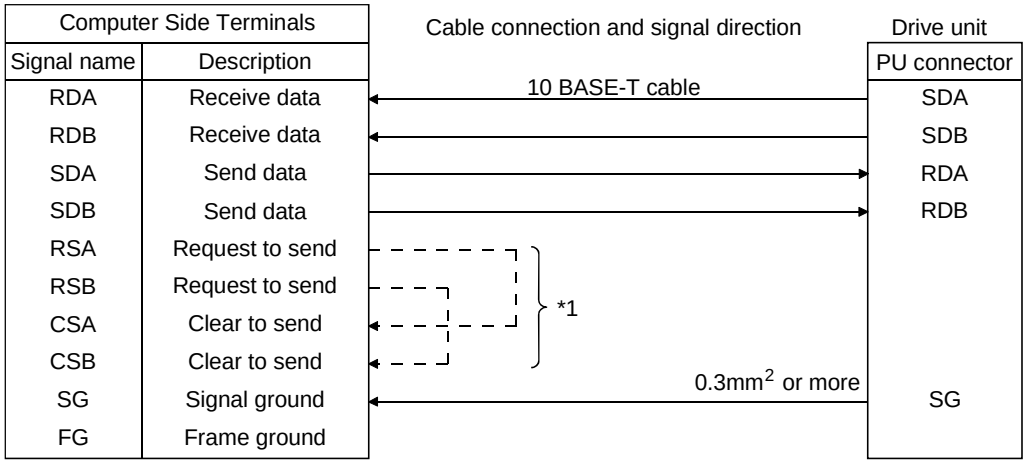
● Parts used (Use commercially available parts for wiring)

Connector	RJ45 connector Example: 5-554720-3, Tyco Electronics Corporation
Cable	Cable conforming to EIA568 (such as 10BASE-T cable) Example: SGLPEV 0.5mm × 4P (Twisted pair cable, 4 pairs), Mitsubishi Cable Industries, Ltd.
Commercially available converter	Examples Model: FA-T-RS40 converter Nagoya Sales Office Mitsubishi Electric Engineering Co., Ltd.

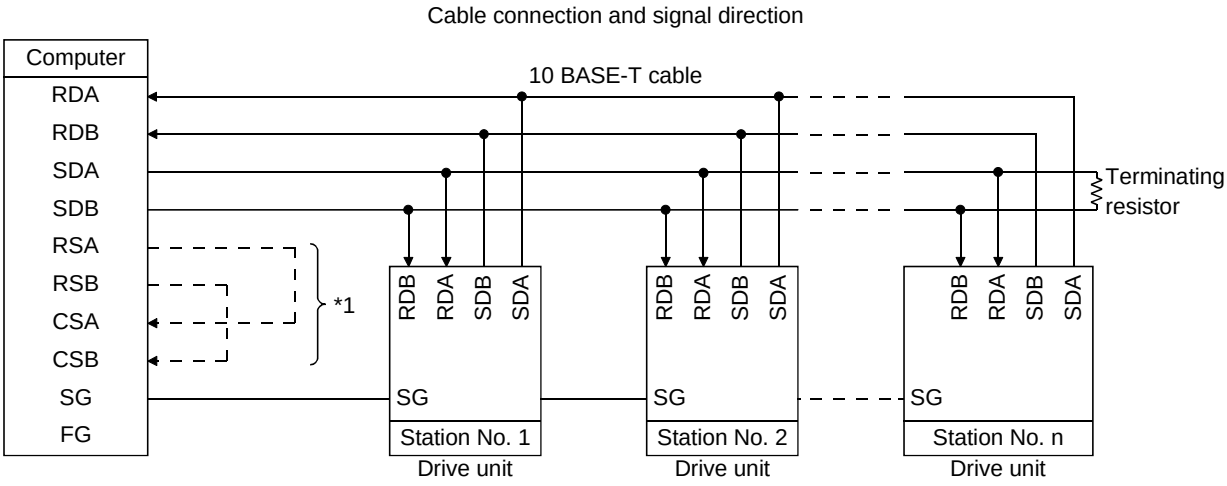
NOTICE	● Do not connect the PU connector to the computer's LAN board, FAX modem socket or telephone modular connector. Doing so may damage the drive unit due to electrical incompatibilities.

3.4.4 Wiring methods for communication operation

1) Wiring of one computer and one drive unit for RS-485



2) Wiring of one computer and "n" drive units for RS-485



NOTICE	● Communication may be affected by reflection depending on the transmission speed and/or transmission distance. Connect a Terminating resistor if reflection interferes with communication. For connection using the PU connector, use a splitter since the termination resistor cannot be fitted. Connect the Terminating resistor to only the remotest drive unit from the computer. (Terminating resistor: 100Ω) ● Connect the terminals marked *1 in accordance with the instruction manual of the computer used. Fully check the terminal numbers of the computer as they differ between models.

4. HOW TO USE THE OPERATION PANEL

This chapter provides instructions on how to use the operation panel (FR-DU04) of the drive unit.

MEMO	● For the way to use the FR-PU04 parameter unit, refer to the instruction manual of the FR-PU04 parameter unit. Note that when the FR-PU04 is used, there are restrictions on some of the FR-PU04 functions. **Refer to: 4.4 Restrictions for Use of the FR-PU04**

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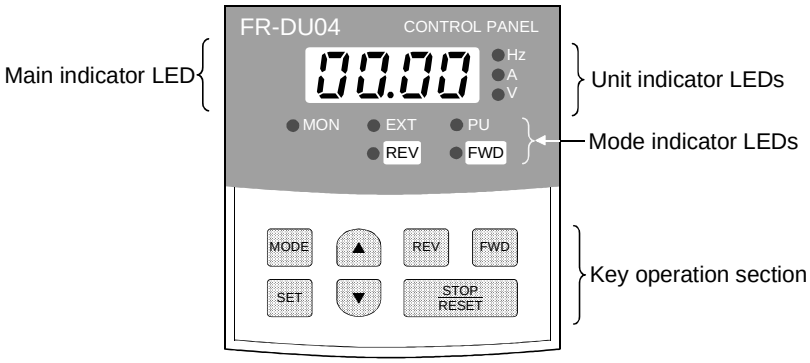
4.2 Operation Modes 4-3

4.3 Operation Procedures 4-4

4.4 Restrictions for Use of the FR-PU04 4-8

4.1 Part Names and Functions



Name				Function
Main indicator LED (4 digits)				Indicates the speed, output current and other monitored values and various function settings.
Unit indicator LEDs ○: On ●: Off	Hz	A	V	
	●	●	●	For speed (r/min), machine speed monitoring
	○	●	●	For frequency monitoring
	●	○	●	For current monitoring
	●	●	○	For voltage monitoring
Mode indicator LEDs ○: On △: Flicker ●: Off	MON			Lit in the monitor mode.
	EXT	PU		
	○	●		Indicate external operation mode.
	●	○		Indicate PU operation mode, speed setting mode, or parameter setting mode.
	○	○		Indicate external/PU combined operation mode 1, 2.
	●	●		Indicate help mode.
	REV	FWD		
	●	△		Indicate forward rotation operation
	△	●		Indicate reverse rotation operation
	●	●		Indicate stop
Key operation section	MODE			Used to select the monitor, speed setting, parameter setting, operation mode or help mode.
	▲ ▼ (UP/DOWN)			Used to change the speed setting, parameter number, set value or help item. Press ▲ to increase or ▼ to decrease.
	SET			Used to confirm operation, e.g. determine the speed setting or parameter setting.
	REV			Used to start operation in the reverse rotation direction.
	FWD			Used to start operation in the forward rotation direction.
	STOP/RESET			Used to decelerate the running motor to a stop. Functions as an alarm reset key when the motor has stopped with an alarm indication.

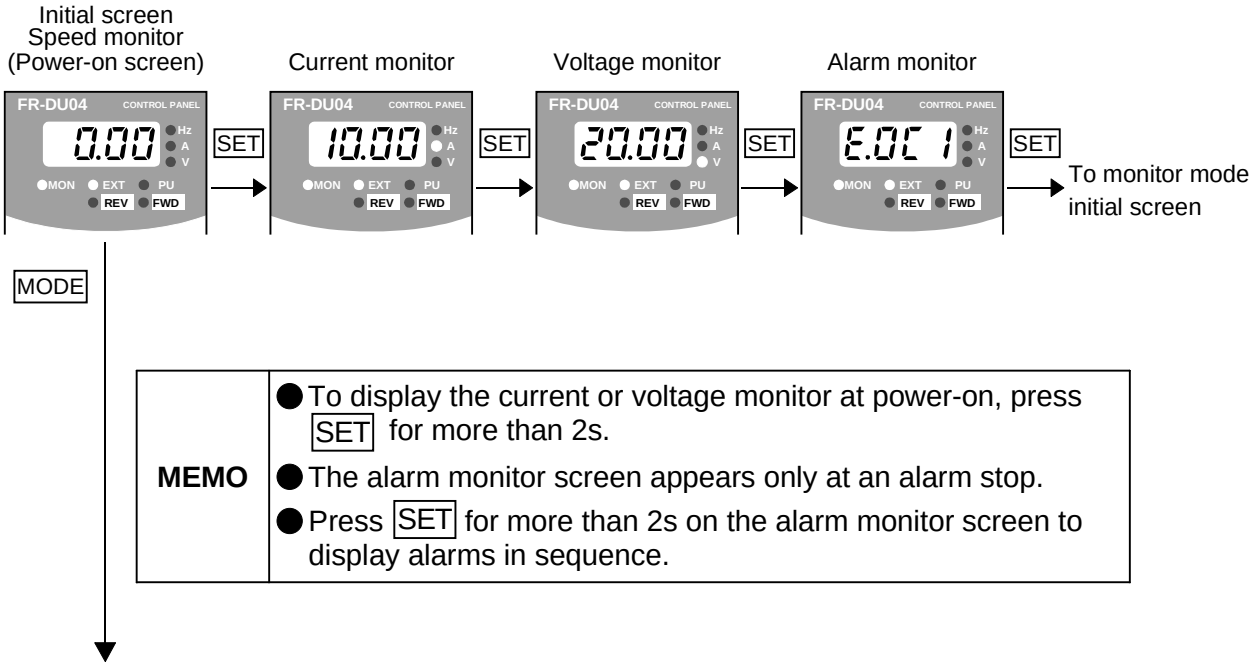
4.2 Operation Modes

The operation panel can be used to stop operation, set the speed, monitor the operation command/status, display an alarm, and copy the parameter values. Press the MODE key to display each mode in sequence.

Mode	Description	
Monitor mode	Used to display the speed, motor current or output voltage. Setting the parameter function enables another item to be displayed. **Refer to: Chapter 8, 8.7.1 Selection of operation panel display data**	
Speed setting mode	Used to enter the speed command from the operation panel. Displayed only in the PU operation mode or PU/external combined operation mode 1, 2. **Refer to: Chapter 5 Operation**	
Parameter setting mode	Used to set the parameter values.	
Operation mode	You can select the external, PU or PU JOG operation. You can fix the operation method by setting the parameter function. **Refer to: Pr. 79 [Section 8.2]**	
Help mode	The help mode enables the following functions.	
	Alarm history read	Used to read the last four alarms. The latest alarm is indicated by "." which follows the character E. E. _ _0 appears to indicate no alarm.
	Alarm history clear	Used to clear all the alarm history.
	Parameter clear	Used to initialize the parameter settings to the factory settings. Pr. 75, Pr. 180 to Pr. 195, Pr. 900 to Pr. 905 and control parameters are not initialized. You can disable parameter clear by setting the parameter function. **Refer to: Pr. 77 [Section 8.1]**
	All clear	Used to clear all the parameter settings and calibration values to the factory settings. Pr. 71, Pr. 75, Pr. 80 and Pr. 188 are not initialized.
	User clear	Used to initialize the user-set parameter values. The other parameters are initialized to the factory settings. Pr. 75, Pr. 180 to Pr. 195 and control parameters are not initialized. **Refer to: Pr. 199 [Section 8.1]**
Copy mode	You can copy the parameter settings to another drive unit. You can not copy them between the drive units whose capacities differ. If you have copied them accidentally, perform the all clear function for the drive unit of the copy destination. Also, you cannot copy the parameter values to the drive unit which is not the MD-AX520 series. (E. rE4 model error appears.)	

4.3 Operation Procedures

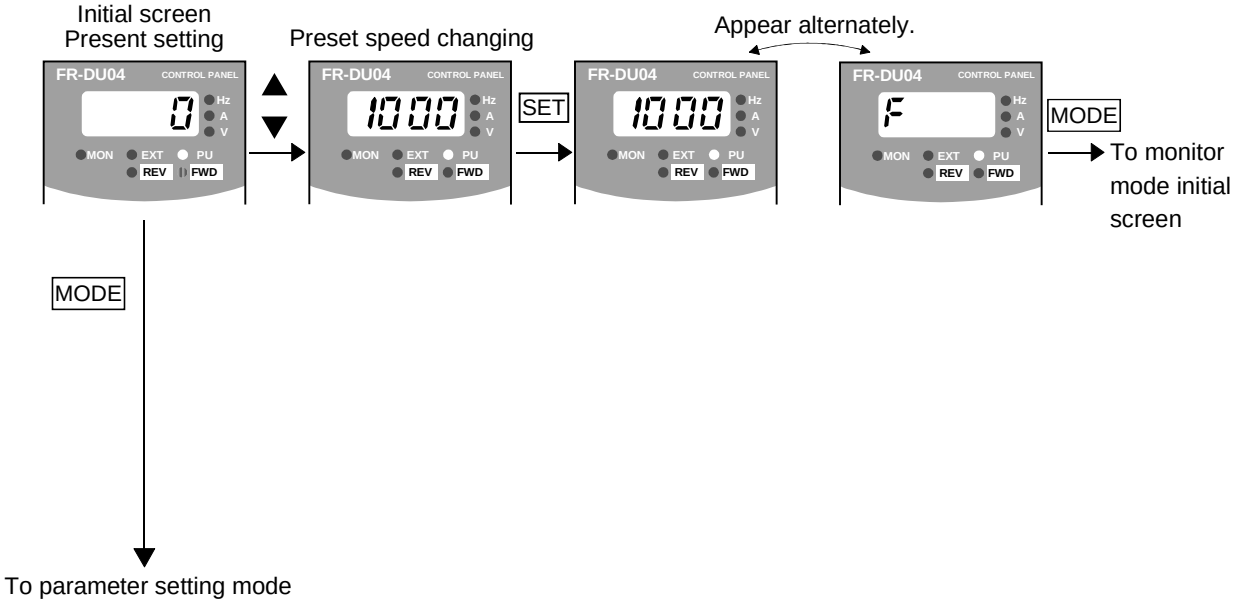
(1) Monitor mode



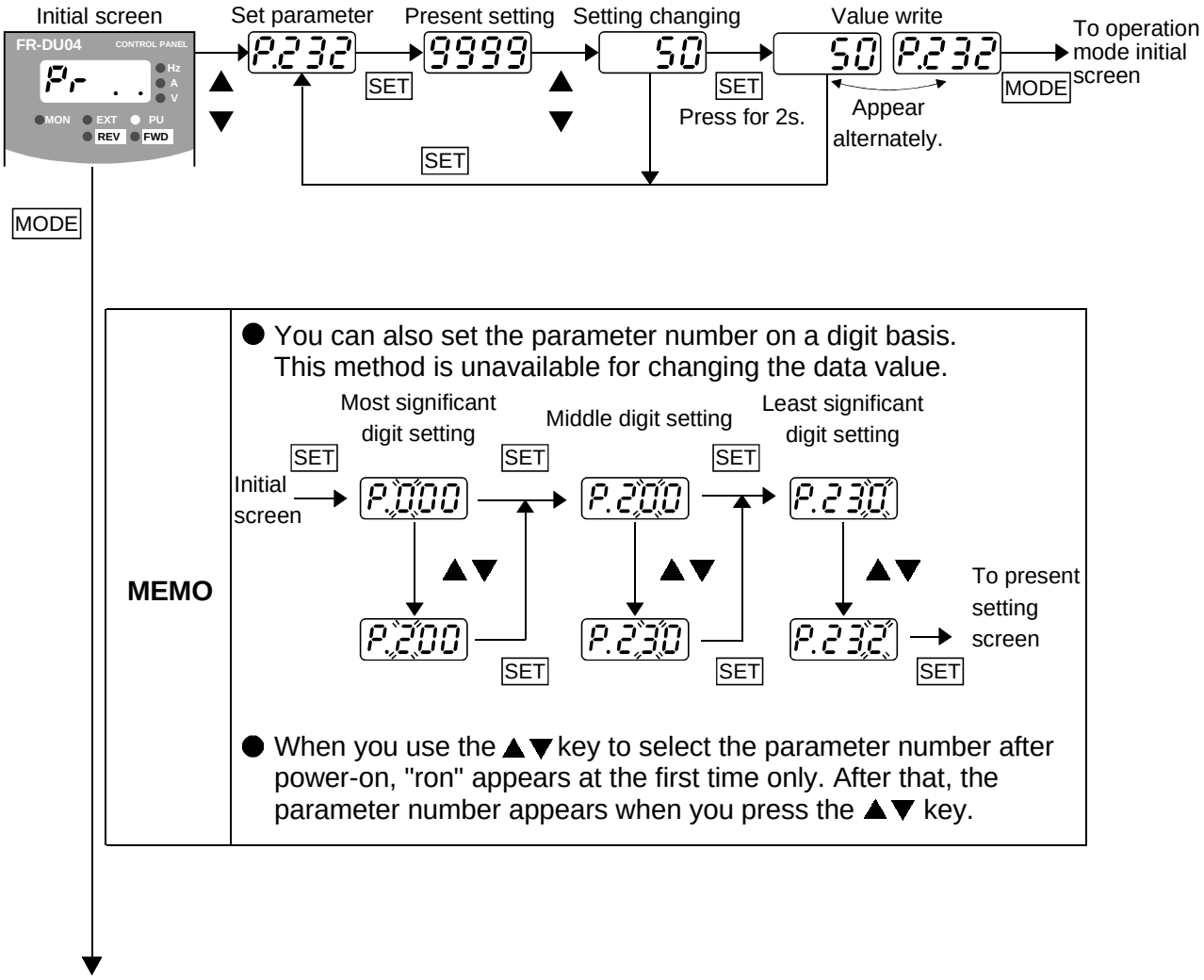
MEMO	
	● To display the current or voltage monitor at power-on, press SET for more than 2s.
	● The alarm monitor screen appears only at an alarm stop.
	● Press SET for more than 2s on the alarm monitor screen to display alarms in sequence.

(2) Speed setting mode

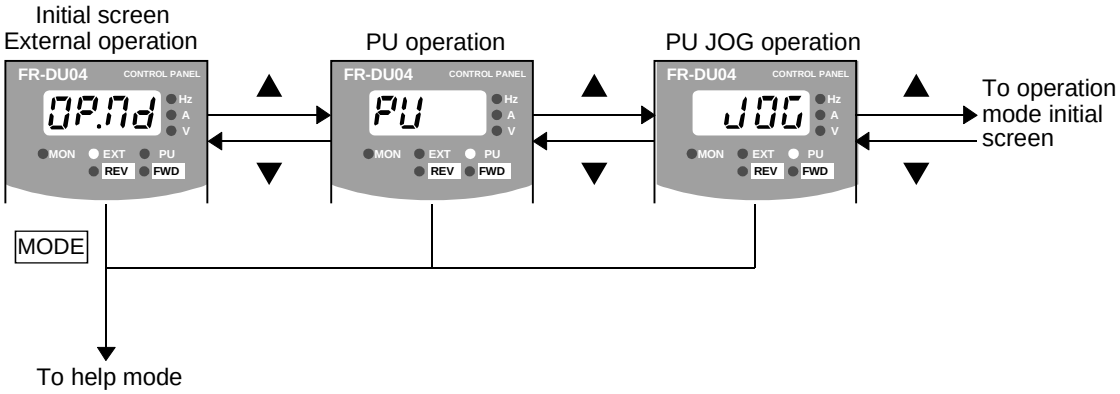
Setting example: Setting of speed to 1000r/min



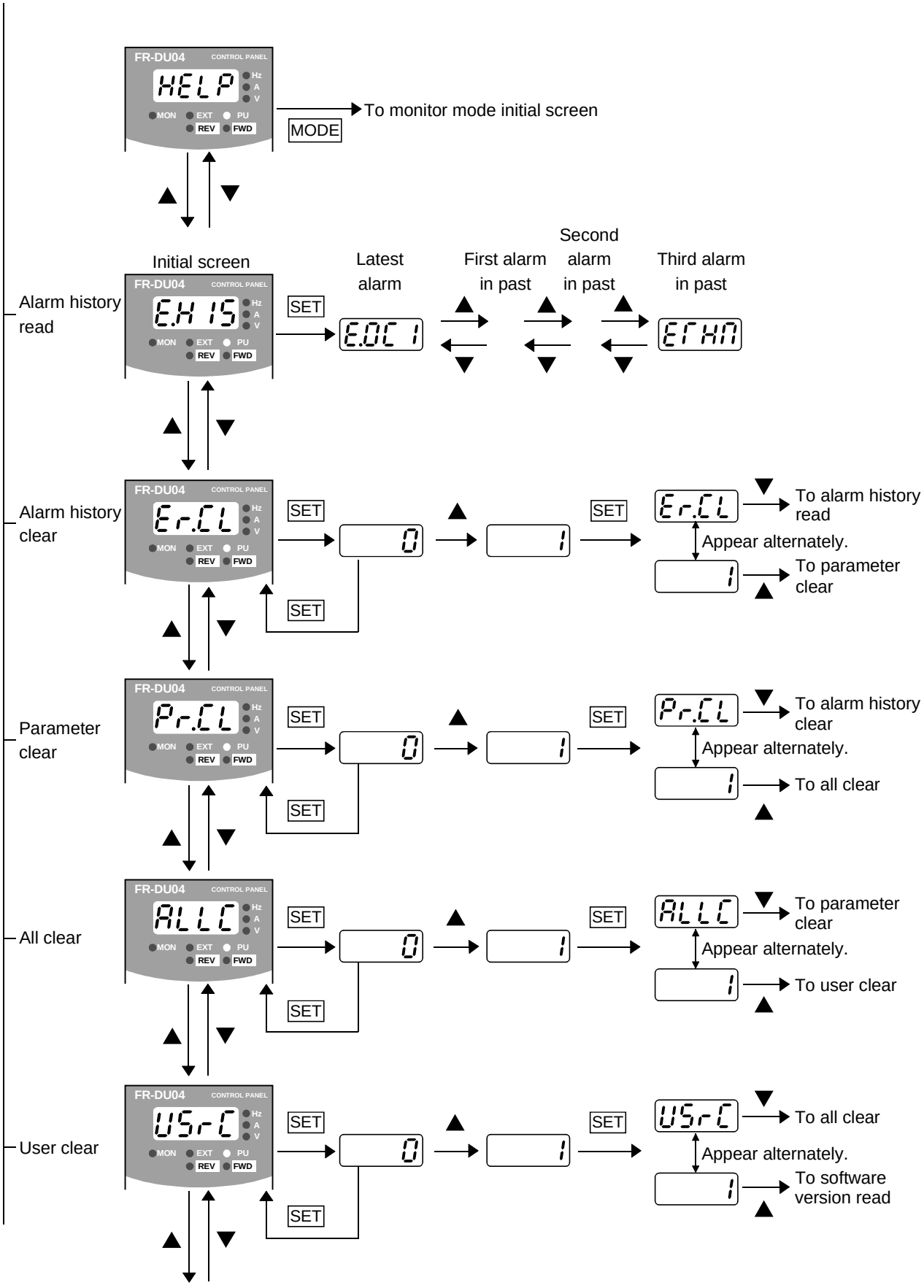
(3) Parameter setting mode Setting example: Setting of 50 in Pr. 232

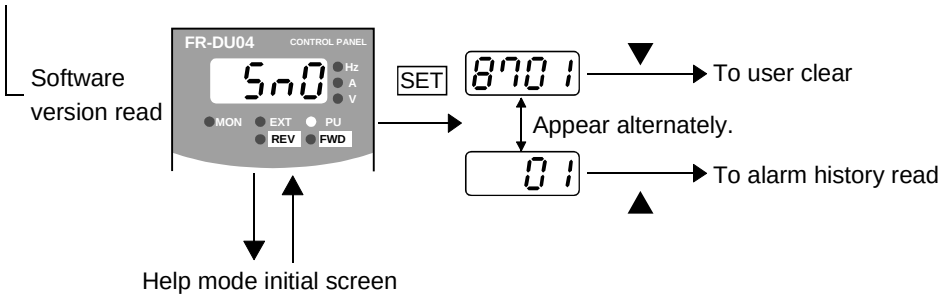


(4) Operation mode



(5) Help mode

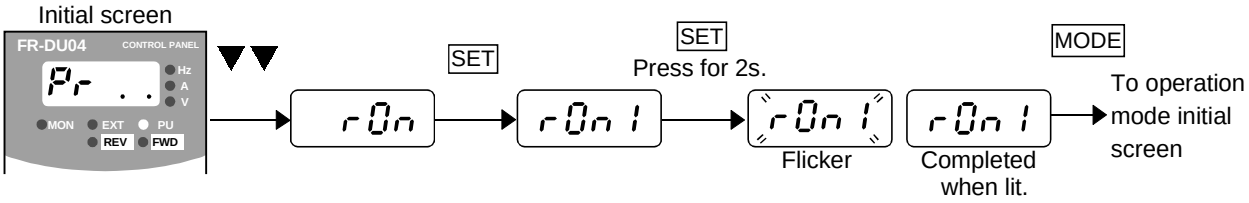

FR-DU04
CONTROL PANEL
HELP
To monitor mode initial screen
MODE
Initial screen
Latest alarm
First alarm in past
Second alarm in past
Third alarm in past
Alarm history read
SET
E.OC1
ETHN
Alarm history clear
Er.CL
0
1
To alarm history read
Appear alternately.
To parameter clear
Parameter clear
Pr.CL
To all clear
All clear
ALLC
To user clear
User clear
USrC
To software version read



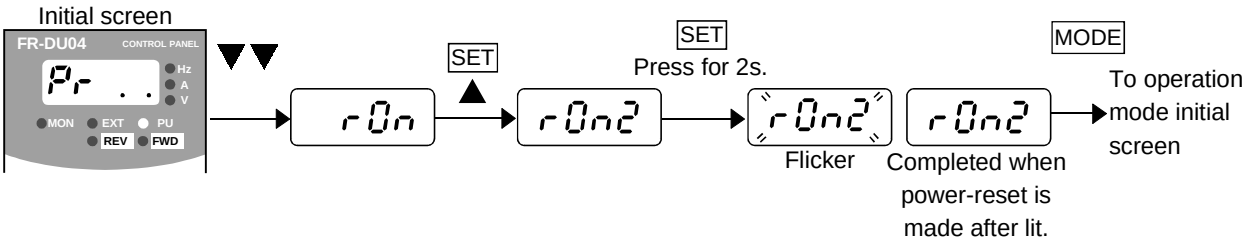
MEMO	● Pressing SET on the alarm history display screen shows the speed, current and voltage at alarm occurrence. (This function is invalid for the IPF alarm. "0"s appear for all indications.) ● Any of the parameter clear, all clear and user clear operations can be performed in the PU operation mode or PU/external combined operation mode 1, 2. "Err" flickers in the external operation mode.

(6) Parameter copy mode (Start operation from the initial screen of the parameter setting mode)

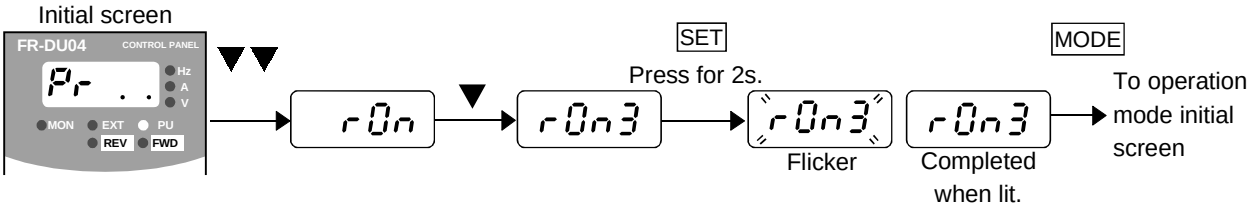
1) Parameter read operation



2) Parameter write operation



3) Write parameter verify



MEMO	● When you have completed parameter write, always power "OFF" the drive unit once to reset before starting operation. ● Restart operation from the beginning if the read error E. rE1 or write error E. rE2 appears during operation. ● If a data discrepancy occurs during parameter verify, the corresponding parameter number and "verify error (E. rE3)" appear alternately. If the preset speed or JOG speed setting of the operation panel is discrepant, the "verify error (E. rE3)" appears. To ignore the error and continue verify, press the SET key. ● Copying cannot be done if "1" is set in Pr. 77 "parameter write disable selection" of the copy destination drive unit. **Refer to: Chapter 8, 8.1 Protection and Editing of the Parameters**

4.4 Restrictions for Use of the FR-PU04

When the FR-PU04 parameter unit (option) is used, some of the FR-PU04 functions are unavailable.

(1) Parameter unit display language

- Data may be displayed in Japanese only. It cannot be changed to any other language.

(2) Parameter names and setting ranges

- The parameter names (katakana characters) do not appear. (Except Pr. 900 to Pr. 905)
- The parameter setting ranges do not appear.

(3) Function-by-function parameter setting feature

- Invalid.

(4) Help function

- The parameter list does not appear.
- The parameter change list does not appear.
- The troubleshooting function is unavailable. "The remedy screen for "デンリュウガオオキイ" appears but the corresponding parameter function does not exist.
- Function "タンシワリツケ" appears only for the "RL, RM, RH, RT, AU, JOG, CS" contact input terminals.

5. OPERATION

This chapter gives the basic operation methods of the drive unit.

⚠ CAUTION
● **If the machine should become out of control, perform test operation after ensuring safety.** ● **Start operation after performing test operation under light load at low speed to ensure that operation is performed safely.** ● **Check that the machine has no damage.** ● **Securely set the parameter values to match the operating machine system environment.**

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5.1 Power On

Switch power on after making sure that the unit has been installed and wired properly and that the start signal is OFF.
The LEDs and POWER lamp of the operation panel are lit.

NOTICE	● If the LEDs do not come on, check the following: • There is no contact fault in the connection of the operation panel and the drive unit; • The jumper across the DC reactor connection terminals P/+-P1 is fitted properly; and • The jumper across the control circuit power supply terminals R1-S1 is fitted properly.

5.2 Parameter Setting

5.2.1 Setting of the operation mode parameter

Depending on the start signal (forward rotation command, reverse rotation command, stop command) and speed setting signal input method, you may need to set the parameter.
Choose the used operation mode in Pr. 79 [Section 8.2].

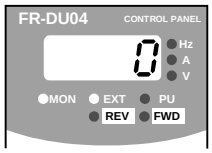
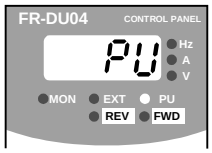
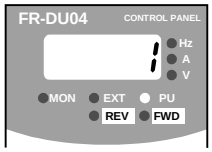
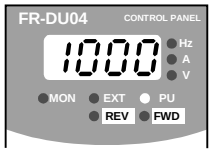
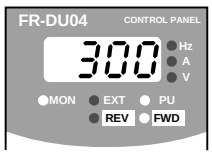
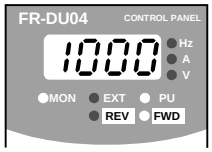
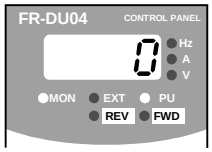
5.2.2 Confirmation of the basic operation parameters

To meet various applications, a wealth of parameter functions are available for the drive unit. The drive unit is designed to perform simple variable-speed operation using the parameter values set before shipment from the factory. Depending on the specification conditions of the load (machine), however, some parameter values may need to be checked and changed.
The parameters marked BASIC in the table of contents of Chapter 8 PARAMETER FUNCTIONS are the basic operation parameters whose values are recommended to be checked prior to operation. Set them to values which match the specification conditions of the load.

5.3 Operation Examples

5.3.1 PU operation mode

(1) When performing operation by setting the running speed (1000r/min) with the ▲▼ (UP/DOWN) key

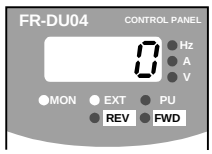
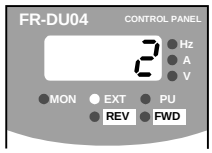
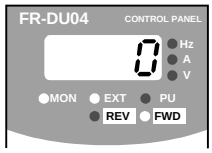
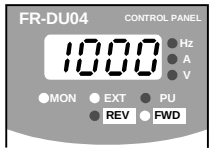
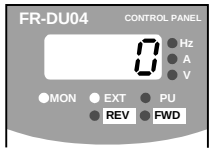
Step	Operation Procedure (from Factory Setting)	Display (on Completion of Operation)
1. Confirm the operation mode.	1) When power is switched on, the "MON" mode indicator LED of the operation panel is lit and the monitor screen appears.	
	2) Choose PU operation on the operation mode screen and set 1 in Pr. 79 [Section 8.2] in the parameter setting mode. (When Pr. 79=0, the drive unit is placed in the external operation mode at power-on. Therefore, you need to change the external operation mode to the PU operation mode every time power is switched on.) Selecting the PU operation mode lights up the "PU" mode indicator LED of the operation panel.	 
2. Set the running speed.	1) Press the MODE key to display the speed setting mode screen.	
	2) Set the running speed with the ▲▼ key.	
3. Enter the start signal.	1) Press the FWD key to start the motor running in the forward rotation direction or the REV key to start it running in the reverse rotation direction, increasing the speed in accordance with the preset acceleration time.	
	2) The display screen changes automatically from the speed setting mode screen to the monitor mode screen. The "FWD" mode indicator LED flickers to indicate forward rotation, or the "REV" mode indicator LED flickers to indicate reverse rotation.	
	3) Acceleration is complete when the main indicator LED shows the preset speed.	
4. Enter the stop signal.	1) Press the STOP/RESET key to decelerate the motor to a stop in accordance with the preset deceleration time. After stopping, the "FWD" or "REV" mode indicator LED goes off.	

(2) When performing JOG operation by operating the keys of the operation panel

Refer to: Chapter 8, 8.6.1 JOG operation

5.3.2 External operation mode

(1) When performing operation using the analog speed command (voltage input)

Step	Operation Procedure (from Factory Setting)	Display (on Completion of Operation)
1. Confirm the operation mode.	1) When power is switched on, the "MON" mode indicator LED of the operation panel is lit and the monitor screen appears.	
	2) Choose PU operation on the operation mode screen and set 0 or 2 in Pr. 79 [Section 8.2] in the parameter setting mode. Selecting the external operation mode lights up the "EXT" mode indicator LED of the operation panel.	 
2. Enter the start signal.	1) Turn on the start signal connected to the terminal STF (or STR). 2) The "FWD" (or "REV") mode indicator LED flickers.	
3. Enter the running speed signal.	1) Entering the speed setting signal to the terminal 2 runs the motor. 2) The speed rises in proportion to the increase of the speed setting signal.	
4. Enter the stop signal.	1) Decreasing the speed setting signal of the terminal 2 reduces the speed. 2) After the speed reaches zero, turning off the start signal extinguishes the "FWD" or "REV" mode indicator LED.	

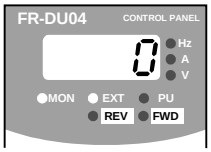
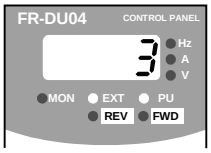
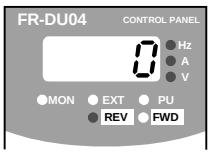
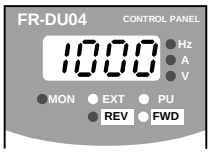
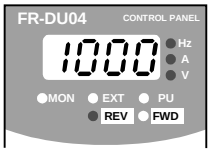
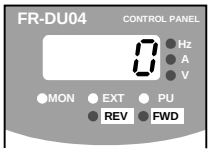
MEMO	● For the analog command, the motor speed varies at the change ratio (slope) of the input signal, but it cannot vary faster than the preset acceleration or deceleration time. To control the speed in response to the input signal's change ratio, set the acceleration/deceleration time to "0". ● You may turn the start signal on/off to start operation after entering the speed setting signal. In this case, the motor speed rises or falls in accordance with the preset acceleration/deceleration time. ● Use Pr. 902 to 905 [Section 8.3.1] to change the relationship between the analog speed command and motor speed.

(2) When performing JOG operation using the terminal STF, STR

Refer to: Chapter 8, 8.6.1 JOG operation

5.3.3 External/PU combined operation mode 1

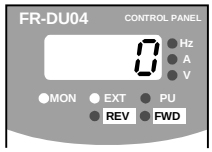
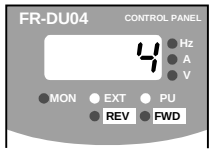
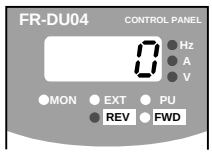
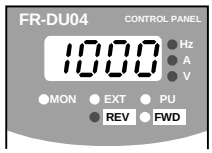
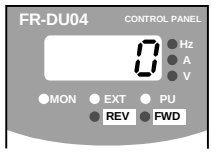
When performing operation by setting the running speed (1000r/min) with the ▲▼ (UP/DOWN) key

Step	Operation Procedure (from Factory Setting)	Display (on Completion of Operation)
1. Confirm the operation mode.	1) When power is switched on, the "MON" mode indicator LED of the operation panel is lit and the monitor screen appears.	
	2) Choose PU operation on the operation mode screen and set 3 in Pr. 79 [Section 8.2] in the parameter setting mode. Selecting the external/PU combined operation mode lights up the "PU" and "EXT" mode indicator LEDs of the operation panel.	
2. Enter the start signal.	1) Turn on the start signal connected to the terminal STF (or STR).	
	2) The "FWD" (or "REV") mode indicator LED flickers.	
3. Set the running speed.	1) Press the MODE key to display the speed setting mode screen. Set the running speed with the ▲▼ key.	
	2) When the running speed is set, the motor speed rises in accordance with the preset acceleration time.	
	3) The display screen changes automatically from the speed setting mode screen to the monitor mode screen.	
	4) When the main indicator LED shows the preset speed, acceleration is complete and the constant-speed operation starts at the preset speed.	
4. Enter the stop signal.	1) Turn off the start signal. The motor decelerates to a stop in accordance with the preset deceleration time. When the speed zeroes, the "FWD" or "REV" mode indicator LED goes off.	

5

5.3.4 External/PU combined operation mode 2

When performing operation using the analog speed command (voltage input)

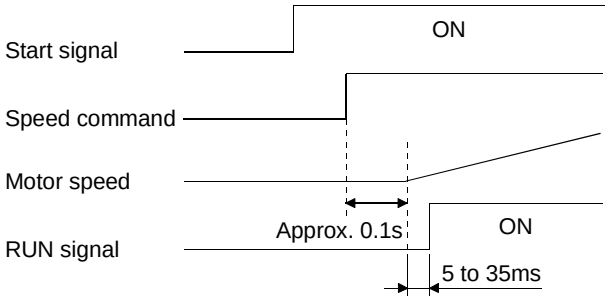
Step	Operation Procedure (from Factory Setting)	Display (on Completion of Operation)
1. Confirm the operation mode.	1) When power is switched on, the "MON" mode indicator LED of the operation panel is lit and the monitor screen appears.	
	2) Choose PU operation on the operation mode screen and set 4 in Pr. 79 [Section 8.2] in the parameter setting mode. Selecting the external/PU combined operation mode lights up the "PU" and "EXT" mode indicator LEDs of the operation panel.	
2. Enter the start signal.	1) Pressing the FWD key flickers the "FWD" operation status indicator LED. Pressing the REV key flickers the "REV" operation status indicator LED.	
3. Set the running speed.	1) Entering the speed setting signal to the terminal 2 runs the motor. The speed rises in proportion to the increase of the speed setting signal.	
4. Enter the stop signal.	1) Press the STOP/RESET key to decelerate the motor to a stop in accordance with the preset deceleration time. After a stop, the "FWD" or "REV" mode indicator LED goes off.	

MEMO	● For the analog command, the motor speed varies at the change ratio (slope) of the input signal, but it cannot vary faster than the preset acceleration or deceleration time. To control the speed in response to the input signal's change ratio, set the acceleration/deceleration time to "0". ● You may turn the start signal on/off to start operation after entering the speed setting signal. In this case, the motor speed rises or falls in accordance with the preset acceleration/deceleration time. ● Use Pr. 902 to 905 [Section 8.3.1] to change the relationship between the analog speed command and motor speed.

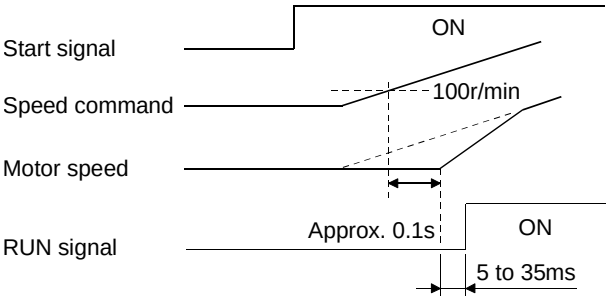
5.3.5 Starting operation

The drive unit detects the magnetic pole of the motor at every start. The magnetic pole detection time is approx. 0.1s (85ms±15ms) after the start signal and speed signal are input. During this period, the motor remains stopped and starts running after magnetic pole detection is finished.

● When inputting the speed command from the operation panel or as a contact signal



● When inputting the speed command as an analog signal



MEMO	● When the start signal is entered after the input of the speed command, the motor starts running approx. 0.1s after the input of the start signal. ● When the analog signal is used to give the speed command, the motor starts running approx. 0.1s after the speed command has reached the value equivalent to 100r/min (value set in Pr. 13). ● For forward/reverse rotation operation, there is an about 0.1s to 3.0s stop depending on the operating conditions.

NOTICE	● When restarting the motor after decelerating it to a stop, start the motor after ensuring that it has stopped. If you start the motor that has not yet come to a complete stop, sufficient torque may not be provided. Especially when the load torque (friction torque) is small and the load inertia moment is large, the motor will run slightly even after the voltage braking operation has stopped. Therefore, restart the motor after making sure that it has stopped completely. **Refer to: Chapter 8, 8.5.4 Stopping operation**

6. TROUBLESHOOTING

This chapter describes how to remedy a fault which occurred in your drive unit or motor and the maintenance and inspection of the drive unit.

NOTICE	● If you have found any fault, immediately perform inspection and take action to remove its cause. If you cannot identify the cause and resolve the malfunction, contact your sales representative.

⚠ WARNING

- **At occurrence of an alarm, turn off the operation signal before resetting the alarm. Resetting the alarm with the operation signal on will restart the motor suddenly. It can cause injury.**
- **At occurrence of an alarm, immediately turn off the operation signal. Not doing so may reset the alarm due to power OFF-ON, e.g. instantaneous power failure, restarting the motor suddenly. It can cause injury.**

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6.1 Message Appearing on the Operation Panel

6.1.1 Protective function activated

When the protective function is activated, any of the following messages may appears on the operation panel or parameter unit. At this time, the ALARM lamp is lit, the drive unit output is shut off, and the motor, if running, coasts.

MEMO	● That the protective function has been activated can be exported from the control circuit output terminal. **Refer to: Chapter 8, 8.7.2 Selection of the control circuit output terminal functions**

When the protective function is activated, perform inspection and take action in accordance with Table 6-1 to remove its cause.

● To restart, reset the drive unit in any of the following methods.
- Switch power off once, then on again.
- Short the terminals RES-SD for more than 0.1s.
- Press the STOP/RESET key of the operation panel or parameter unit.

Table 6-1

Indication		**Protective Function Name Detection Level**	**Estimated Cause (●) and Corrective Action (•)**
Operation panel (Actual characters)	**Parameter unit**		
E.0C 1 (E. 0C1)	カソクジ カデンリュウ	**Acceleration-time overcurrent** Output current is more than 200% of motor rating.	● The acceleration torque is beyond the drive unit capability. • Increase the acceleration time. • Change the acceleration/deceleration pattern to an S shape. ● Outputs U, V and W are in a short circuit or ground fault. • Check the motor winding resistance. • Check the connection cables for damage. ● The motor restarted during coasting. • Restart it after a complete stop. ● The start signal was given with power supplied to the R1, S1 terminals only. • Supply main circuit power (R, S, T). ● The capacity of the drive unit does not match that of the motor.
E.0C2 (E. 0C2)	テイソクジ カデンリュウ	**Constant speed-time overcurrent** Output current is more than 200% of motor rating.	● Excessive load was applied instantaneously. ● Outputs U, V and W resulted in a short circuit or ground fault during constant-speed operation. • Check the motor winding resistance. • Check the connection cables for damage. ● The capacity of the drive unit does not match that of the motor.
E.0C3 (E. 0C3)	ゲンソクジ カデンリュウ	**Deceleration-time overcurrent** Output current is more than 200% of motor rating.	● The deceleration torque is beyond the drive unit capability. • Increase the deceleration time. • Change the acceleration/deceleration pattern to an S shape. ● Outputs U, V and W resulted in a short circuit or ground fault during deceleration operation. • Check the motor winding resistance. • Check the connection cables for damage. ● The mechanical brake of the motor operates too early. • Delay the operation timing. ● The capacity of the drive unit does not match that of the motor.

Table 6-1 (Continued)

Indication		Protective Function Name Detection Level	Estimated Cause (●) and Corrective Action (•)
Operation panel (Actual characters)	**Parameter unit**		
E. GF (E. GF)	チラク カデンリュウ	**Output side ground fault overcurrent**	● Any of outputs U, V, W is in a ground fault.
E.0u 1 (E. 0V1)	カソクジ カデンアツ	**Acceleration-time overvoltage** Main circuit DC voltage is more than 400V.	● Surge compounded with power during acceleration operation. • Install a reactor. • Fit a surge suppressor or like to the surge source. ● The regenerative energy handling capability is insufficient. • Fit the regenerative brake option.
E.0u2 (E. 0V2)	テイソクジ カデンアツ	**Constant speed-time overvoltage** Main circuit DC voltage is more than 400V.	● Surge compounded with power during acceleration operation. • Install a reactor. • Fit a surge suppressor or like to the surge source. ● Load increased suddenly, activating the stall prevention function. ● The regenerative energy handling capability is insufficient. • Fit the regenerative brake option.
E.0u3 (E. V3)	ゲンソクジ カデンアツ	**Deceleration-time overvoltage** Main circuit DC voltage is more than 400V.	● The deceleration torque is beyond the drive unit capability. • Increase the deceleration time. • Change the acceleration/deceleration pattern to an S shape. ● The regenerative energy handling capability is insufficient. • Fit the regenerative brake option. ● Surge compounded with power during deceleration operation or stop. • Install a reactor. • Fit a surge suppressor or like to the surge source.
E.THT (E. THT)	トランジスタ ホゴサーマル	**Electronic overcurrent protection** **Refer to: Pr. 9 [Section 8.5.8]**	● The motor and drive unit are operated under overload. • Reduce the load. • Increase the capacities of the motor and drive unit.
E.THM (E. THM)	デンシ サーマル		
E.IPF (E. IPF)	シュンジ テイデン	**Instantaneous power failure** 15 to 100ms.	**MEMO** An instantaneous power failure occurred.
E.UVT (E. UVT)	フソク デンアツ	**Undervoltage** Power supply voltage is less than about 150V.	● Large-capacity equipment was started nearby. ● The jumper across terminals P/+-P1 has been disconnected. • Connect the jumper or DC reactor.
E.FIn (E. FIN)	フィン カネツ	**Fin overheat** Heat sink temperature is higher than the permissible value of the components.	● The ambient temperate exceeded the permissible temperature. ● The cooling fan failed. **MEMO** An alarm signal can be provided by making control circuit output terminal assignment.

Table 6-1 (Continued)

Indication		Protective Function Name Detection Level	Estimated Cause (●) and Corrective Action (•)
Operation panel (Actual characters)	**Parameter unit**		
E.0HT (E. 0HT)	ガイブホゴ	**External fault** —	● The external relay or equivalent component connected to the terminal which had been assigned to the OH signal operated. **Refer to: Chapter 8, 8.4 Selection of the Control Circuit Contact Input Terminal Functions**
E.PUE (E. PUE)	PUヌケ ハッセイ	**PU disconnection** —	● A connection fault of the operation panel or parameter unit occurred. **Refer to: Pr. 75 [Section 8.2]** ● RS-485 communication was interrupted. ● The number of communication retries exceeded the Pr. 121 setting. **Refer to: Pr. 121 [Section 8.6.2]**
E.rET (E. RET)	リトライ カイスウ オーバー	**Retry excess** —	● The number of alarms that occurred exceeded the retry setting. **Refer to: Pr. 67 [Section 8.6.4]**
E.OLT (E. OLT)	ストール ボウシ ニヨリ テイシ	**Stall stop Refer to: Pr. 22 [Section 8.5.6]**	● Motor overload activated the stall prevention function consecutively, stopping the motor. • Reduce the load. • Increase the capacities of the motor and drive unit. ● E. OLT output was selected in Pr. 156. **Refer to Pr. 156 [Section 8.5.6]**
E.LF (E. LF)	シュツリョクケッソウ	**Phase failure**	● A phase failure occurred in any of the outputs U, V, W. **MEMO** If a phase failure occurs during motor operation, the overcurrent protective function may be activated.
E.P24 (E. P24)	P24イジョウ	**P24**	● The PC terminal output of the control circuit is in a short circuit. • Check the wiring. **MEMO** A reset may not be made from the RES terminal. Make a reset in another method.
E.CTE (E.CTE)	—	**Panel power supply**	● The power supply cable of the operation panel or parameter unit is in a short circuit. • Check the cable wiring.
E.OPT (E. OPT)	オプション イジョウ	**Option fault** —	● The plug-in option fitted is other than the specified. ● Power was switched on for the R, S, T of the drive unit with the setting of the high power factor converter connection (Pr. 30 = 2 [Section 8.5.5]).

If any of the messages in Table 6-2 appears, the drive unit is assumed to have failed. If the same message reappears after an alarm reset, immediately replace the drive unit.

Table 6-2

Indication		Protective Function Name Detection Level	Estimated Cause (●) and Corrective Action (•)
Operation panel (Actual characters)	Parameter unit		
E.CPU (E. CPU)	CPUエラー	**CPU fault**	● The CPU malfunctioned. ● The CPU failed.
E. 6 (E. 6)	エラー6		
E. 7 (E. 7)	エラー7		
E. PE (E. PE)	パラメータエラー	**Storage device fault**	● The storage device failed.
E. bE (E. BE)	ブレーキカイロイジョウ	**Brake circuit fault**	● The regenerative brake circuit failed. • If E. BE reappears after a reset, immediately switch power off. **Leaving power on will overheat the brake resistor.**

6.1.2 Alarm function activated

If the alarm function is activated during motor operation, any of the displays in Table 6-3 is provided on the operation panel or parameter unit.
If you ignore the alarm message and continue operation, the fault detection function is activated, leading to an operation stop. When you noticed that the alarm function had been activated, immediately remove its cause.

MEMO	● That the alarm function has been activated can be exported as an alarm signal. **Refer to: Chapter 8, 8.7.2 Selection of the control circuit output terminal functions**

Table 6-3

Indication		Protective Function Name Detection Level	Related Protective Function
Operation panel (Actual characters)	Parameter unit		
OL (OL)	OL	**Overload 1** Pr. 22 setting [Section 8.5.6]	**Acceleration-time overcurrent, constant speed-time overcurrent, deceleration-time overcurrent, stall stop**
oL (oL)	oL	**Overload 2** Main circuit DC voltage more than 390V	**Deceleration-time overvoltage**
rb (RB)	RB	**Brake duty** More than 85% of the permissible value	**Deceleration-time overvoltage**
TH (TH)	TH	**Motor overheat** More than 85% of the electronic overcurrent protection level	**Electronic overcurrent protection**
Fn (FN)	FN	**Fan failure** Cooling fan fault **Refer to: Pr. 244 [Section 8.5.8]**	**Fin overheat**

6.1.3 Others

Table 6-4

Indication		Protective Function Name Detection Level	Estimated Cause (●) and Corrective Action (•)
Operation panel (Actual characters)	**Parameter unit**		
Err (Err)	(Types of error are displayed)	**Operation error**	● Parameter changing operation was performed during external operation. ● The value that was set is outside the parameter setting range. ● The RES signal remains ON. ● The operation panel is in a connection fault. • Check the fitting status. **MEMO** An operation error does not activate the relay contact output.
PS (PS)	PS	**Emergency stop operation**	● The STOP/RESET key of the operation panel or parameter unit was pressed to make a stop during external operation. **MEMO** A reset cannot be made in the normal method. **Refer to: Pr. 75 [Section 8.2]**
E.rE4 (E. rE4)	—	**Copy error**	● Parameters were copied to a different model. **Refer to: Chapter 4, 4.2 Operation Modes**

6.1.4 Correspondences between digital and actual characters

There are the following correspondences between the actual alphanumeric characters and the digital characters displayed on the operation panel.

Actual	Digital
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Actual	Digital
A	A
B	b
C	C
D	d
E	E
F	F
G	G
H	H
I	I
J	J
L	L

Actual	Digital
M	M
N	n
O	O
o	o
P	P
S	S
T	T
U	U
V	v
r	r
-	-

6.2 Motor operation out of ordinary

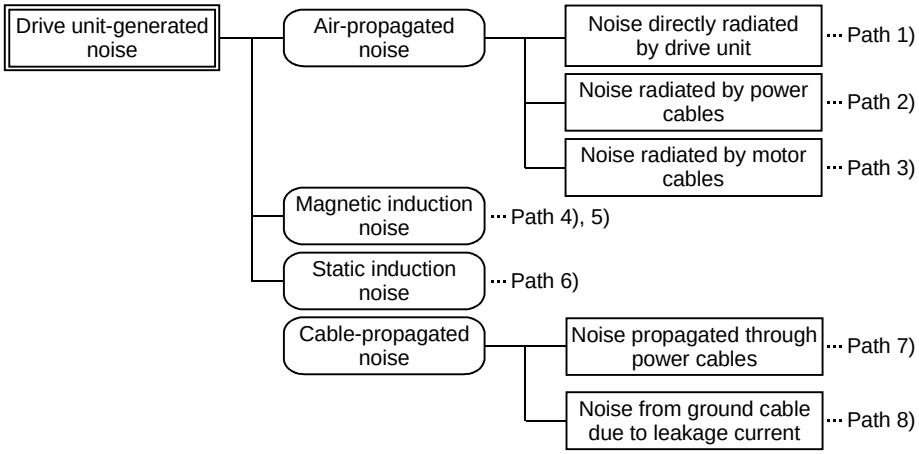
If any of the following faults has occurred in the motor, find out its cause and take adequate measures.

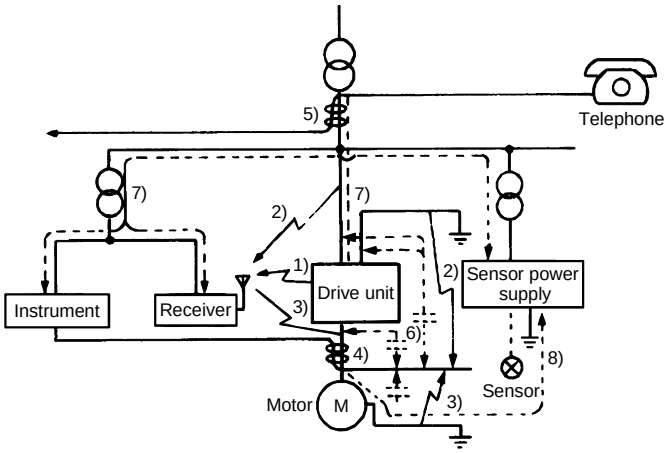
Event	Check Point	Estimated Cause (●) and Corrective Action (•)
Motor remains stopped.	Check the main circuit.	● A normal power supply voltage is not applied. ● The jumper across terminals R1-S1 has been disconnected. ● The jumper across terminals P/+-P1 has been disconnected. ● The motor is not wired properly. ● The switch connected between the motor and drive unit is open.
	Check the control signals.	● The start signal has not been initiated. ● Both the forward and reverse rotation signals are input. ● The speed setting signal is not input. ● The AU signal is not ON for the 4 to 20mA speed setting signal. ● The MRS signal remains ON.
	Check the parameter settings.	● The reverse rotation prevention, Pr. 78 [Section 8.5.1], value has been set. ● The operation mode, Pr. 79 [Section 8.2], setting is incorrect. ● 0 was set as the maximum speed, Pr. 1 [Section 8.5.1], value.
	Check the load.	● The load is too heavy. (The alarm message OL appears.) ● The motor shaft is locked.
	Others	● The alarm lamp is lit. ● The POWER lamp is off. ● The capacities of the drive unit and motor do not match.
Motor rotates in opposite direction.	Check the main circuit.	● The wiring of the motor connection terminals U, V, W does not match the motor phase sequence.
	Check the control signals.	● The wiring of the forward rotation signal (terminal STF) and that of the reverse rotation signal (terminal STR) was exchanged.
Speed differs from the setting.	Check the control signals.	● The speed setting signal differs from the setting. ● The speed setting signal is compounded with noise.
	Check the parameter settings.	● The speed signal bias/gain, Pr. 902 to 905 [Section 8.3.1], values have been set. ● The maximum speed, Pr. 1 [Section 8.5.1], value or minimum speed, Pr. 2 [Section 8.5.1], value has been set. ● The stall prevention function, Pr. 22 [Section 8.5.6] was activated. • Increase the acceleration or deceleration time setting. • Reduce the load.
Acceleration/ deceleration is not smooth.	Check the parameter settings.	● The stall prevention function, Pr. 22 [Section 8.5.6] was activated. • Increase the acceleration or deceleration time setting. • Reduce the load.
Speed varies.	Check the control signals.	● The speed setting signal varies.
	Check the load.	● The load varies.
At start, motor shaft runs in opposite direction instantaneously.	Check the parameter settings.	● The acceleration time setting is more than that for the maximum permissible starting torque. • Increase the acceleration time setting.

6.3 Noise Malfunctions and Measures

Drive unit-generated noises are largely classified into those radiated by the cables connected to the drive unit and drive unit's main circuit (I/O), those electromagnetically and electrostatically induced to the signal cables of the peripheral devices close to the main circuit cables, and those transmitted through the power supply cables. When the drive unit malfunctions due to peripheral noises, noises also enter in a similar propagation paths.

(1) Noise types and propagation paths





(2) Specific measures

Take the following measures against anticipated noise propagation paths. For the necessity of the measures, refer to the levels (estimated values) of the expected effects.

◎: Large effect, ○: With effect, △: Small effect, —: Without effect

Place	Measures	Noise Propagation Paths						
		Air-propagated noise			Magnetic induction noise	Static induction noise	Cable-propagated noise	
		Radiated by drive unit	Radiated by power cables	Radiated by motor cables			Through power cables	From ground cable
Unit	Decrease the motor tone selection (Pr. 72) setting.	◎	◎	◎	◎	◎	◎	◎
AC power supply side	Install the FR-BIF radio noise filter.	—	◎	—	—	—	◎	—
	Install the FR-BSF01 or FR-BLF line noise filter.	—	◎	—	—	—	◎	△
	Run the power cables in a metal conduit or use shielded cables.	—	◎	—	—	—	◎	—
	Install an insulating transformer or noise cutting transformer.	—	△	—	—	—	◎	—
	Separate the power supply line.	—	—	—	—	—	◎	◎
Motor side	Install the FR-BSF01 or FR-BLF line noise filter.	—	—	◎	△	△	—	◎
	Run the motor cables in a metal conduit or use shielded cables.	—	—	◎	○	○	—	—
	Use a 4-core cable as the motor power cable and use one of its wires as a ground wire.	—	—	△	△	△	—	◎
Control circuit side	Use shielded cables as the signal input cables.	△	△	△	○	◎	—	△
	Use twisted shielded cables as the speed input cables.	○	○	○	◎	◎	—	△
	Insert commercially available ferrite cores into the speed input cables.	△	△	△	○	—	—	—
Mating equipment side	Use twisted shielded cables as the signal cables. Connect the shield sheath to the common of the mating equipment.	○	○	○	◎	◎	—	◎
	Do not run cables in parallel with the drive unit power cable or bundle them together.	△	△	△	◎	◎	—	—
	Install the mating equipment as far away as possible from the drive unit and power cable.	◎	◎	◎	◎	◎	—	—
	Provide a shielding plate between the mating equipment and the drive unit/power cable.	○	△	△	△	△	—	—
	Insert commercially available ferrite cores into the speed input cables and like.	—	—	—	—	—	○	△
	Decrease the output impedance of the speed signal output circuit.	△	△	△	○	—	—	—

6.4 Maintenance and Inspection

⚠ WARNING
● **When performing inspection by removing the front cover or the like, switch power off, wait 10 or more minutes, then check that the voltage across the DC terminals P/+-N/- is less than 30VDC with a tester or like before starting inspection. Not doing so can cause an electric shock.** ● **Any person who is involved in inspection should be fully competent to do the work. Otherwise, an electric shock can occur. Do not disassemble or repair the unit.**

6.4.1 Inspection

(1) Daily inspection

During operation and power-on, visually check for the following faults without removing the cover and like.

1) Faulty motor operation
2) Improper installation environment (ambient temperature, humidity, dust, dirt, etc.)
3) Unusual noise, unusual vibration, foul odor, etc.
4) Overheat trace, discoloration, etc.
5) Improper cooling fan rotation
6) Improper on/off of lamps, LEDs and others
7) Improper meter indications

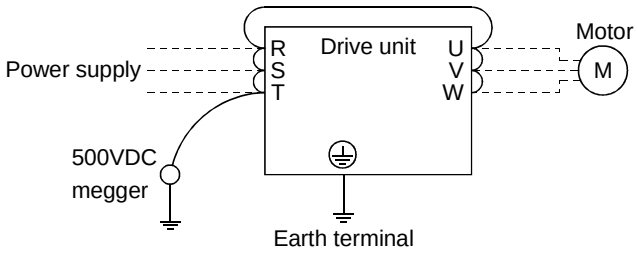
NOTICE	● Always use the drive unit in a clean status. • When cleaning, always switch power off and gently wipe dirty areas with a soft cloth immersed in neutral detergent or ethanol. Do not use detergent or the like to clean the display section of the operation panel or parameter unit. • When cleaning, do not use solvent, e.g. acetone, benzene, toluene or alcohol, as they will cause the drive unit surface paint to peel off.

(2) Periodic inspection

After operation has stopped, switch power off, remove the front cover, and perform periodic inspection referring to Table 6-5 Periodic Inspection List.

Table 6-5 Periodic Inspection List

Area of Inspection		Inspection Items	Methods	Criteria
Surrounding environment		1) Check ambient temperature, humidity, vibration, ambience (for dust, dirt, gas, oil mist, water drops, etc.) 2) Check for tools, foreign matter and dangerous articles in the periphery.	1) Measure visually or with instruments. • Thermometer • Hygrometer • Recorder 2) Visual check.	1) Standard specification values must be satisfied. 2) Must not be left unremoved.
Overall unit		Check for unusual vibration and unusual noise.	Visual and auditory checks.	No fault.
Main circuit	General	1) Check for loose screws and bolts. 2) Check parts and members for deformation, crack, damage, and discoloration caused by overheat or deterioration. 3) Check for contamination and sticking dust and dirt.	1) Retighten. 2), 3) Visual check.	1), 2), 3) No fault.
	Conductors, cables	1) Check conductors for discoloration and distortion caused by overheat. 2) Check cable sheaths for breakage and discoloration.	1), 2) Visual check.	1), 2) No fault.
	Terminal block	Check for damage.	Visual check.	No fault.
	Resistor	Check for foul odor and insulation crack due to overheat.	Olfactory, visual checks.	No fault.
Control circuit	Control printed circuits, connectors	1) Check for loose screws, bolts and connectors. 2) Check for unusual odor and discoloration. 3) Check for crack, damage, deformation, and rust. 4) Check capacitor for liquid leakage and traces of deformation.	1) Retighten. 2) Olfactory, visual checks. 3), 4) Visual check.	1), 2), 3), 4) No fault.
Cooling system	Cooling fan	1) Check for sticking foreign matter. 2) Check for loose connection.	1) Hand turn. 2) Visual check	1) Smooth turn. 2) No fault.
	Ventilation path	Check for clogged heat sink, suction/exhaust ports, and sticking foreign matter.	Visual check.	No fault.

NOTICE	● Insulation resistance test using megger Where possible, do not conduct an insulation resistance test using a megger since an insulation test has been done before shipment from the factory. When it is inevitable to make an insulation resistance test using a megger, disconnect all cables from the control circuit to prevent a test voltage from leaking into the control circuit. The drive unit will fail if the test voltage is applied to the control circuit.  ● Pressure test Do not conduct a pressure test. A pressure test can deteriorate the semiconductor parts in the drive unit.

6.4.2 Wear parts

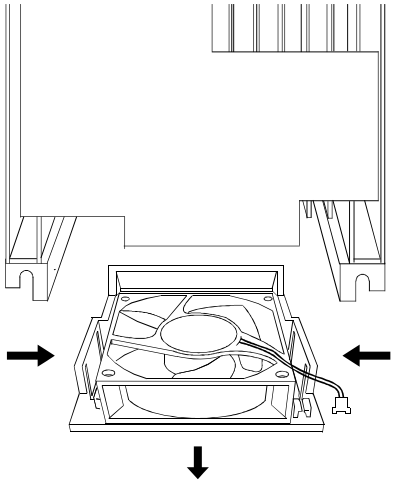
The replacement lives of the parts are as indicated below. Since the lives vary with the operating environment and/or usage, you must replace the parts if you have found any fault during periodic inspection or the like.

Part Name	Standard Replacement Intervals	Method	Remarks
Cooling fan	2 to 3 years	Change (as required)	The bearing life of the cooling fan is 10,000 to 35,000 hours. For continuous operation, therefore, normally replace the fan every 2 to 3 years as a guideline.
Main circuit smoothing capacitor	10 years	Change (as required)	The life greatly depends on the ambient temperature and operation specifications of the drive unit. When continuous operation is performed in normal air-conditioned environment, the life is approximately 10 years. The life halves for each 10°C rise in ambient temperature. The capacitor deteriorates rapidly after the given period has elapsed, causing the motor to run unstably or activating the overcurrent protective function.
On-board smoothing capacitor	10 years	Change (as required)	

6.4.3 Cooling fan replacement method

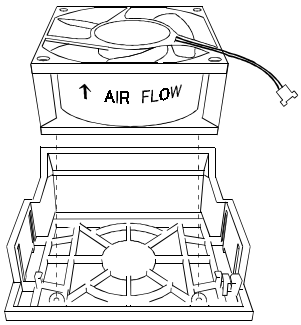
● Removal

1) Remove the cooling fan cover.
   Push the cover in the direction of arrows and pull it down.
2) Unplug the cooling fan connector.
3) Remove the cooling fan from the cooling fan cover.
   The cooling fan is secured by the latches.



● Reinstallation

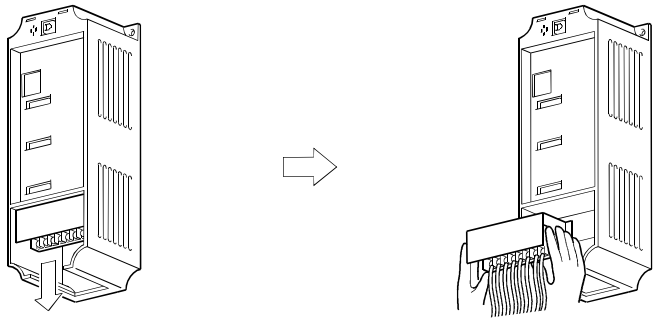
1) After confirming the orientation of the fan, reinstall the fan to the cover so that the arrow on the left of "AIR FLOW" faces in the opposite direction of the fan cover.
   Note: The wrong direction of air flow can shorten the drive unit life.
2) Plug the connector.
3) Reinstall the fan cover to the drive unit.
   Use care to avoid the leads being caught between the chassis and cover.



6.4.4 Drive unit replacement

The drive unit can be changed with the control circuit wiring kept connected. Before replacement, remove the screws in the wiring cover of the drive unit.

1) Remove the mounting screws in both ends of the control circuit terminal block.
2) With both hands, pull down the terminal block from the back of the control circuit terminals.



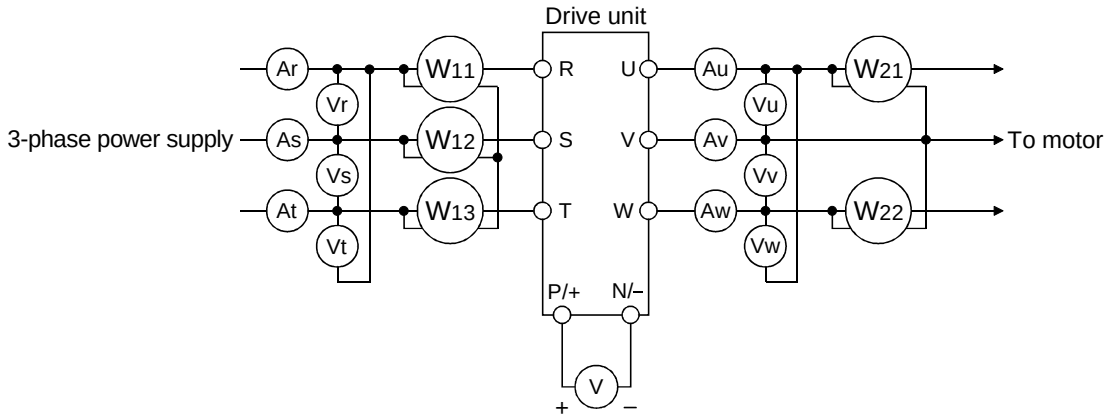
3) When installing the terminal block to a new drive unit, be careful not to bend the pins of the control circuit terminal block connector.

6.4.5 Measurement of circuit current

(1) Measurement of main circuit voltages, currents and powers

Since the voltages and currents on the drive unit's power supply and output sides include harmonics, measured values may vary with the instrument types.
Make measurement in the following method when instruments designed for commercial frequency are used for measurement.

● Measured circuit



Input power=$W_{11}+W_{12}+W_{13}$
Output power=$W_{21}+W_{22}$

● Measuring instruments

Item	Input (Power Supply) Side			Output (Motor) Side			DC Circuit P/+, N/- Terminals
	Voltage waveform / Current waveform			Voltage waveform / Current waveform			
Instrument name	Ammeter Ar, s, t	Voltmeter Vr, s, t	Wattmeter $W_{11, 12, 13}$	Ammeter Au, v, w	Voltmeter Vu, v, w	Wattmeter $W_{21, 22}$	DC voltmeter V
Instrument type	Moving-iron	Rectifier or moving-iron	Electrodynamic	Moving-iron (Note 1)	Rectifier (Note 2)	Electrodynamic	Moving-coil
Instrument signal							

Note 1. When the carrier frequency exceeds 5kHz (Pr. 72 = 3 [Section 8.5.7]), do not use the instrument because eddy current losses occurring in the metallic parts inside the instrument will increase and may lead to burnout.
In this case, use an approximate effective value type instrument.
2. Use an FFT to measure the output voltage accurately. Accurate measurement cannot be made if you use a tester or general measuring instrument.

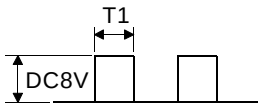
(2) Measurement of power factor

The power factor cannot be measured with a commercially available power-factor meter which is designed to measure the phase difference between a voltage and a current. Measure the power supply side voltage, current and power, then calculate the power factor using the following expression. Calculate the power factor of the motor alone from the output side voltage, current and power.

● Expression

$$\text{Power factor (\%)} = \frac{\text{Power (W)}}{\sqrt{3} \times \text{voltage (V)} \times \text{current (A)}} \times 100$$

(3) Measurement of control circuit signal values

Signal Name	Measured Terminals	Measuring Instrument	Measured Value	
Speed setting signal	Across 2(+)-5	Moving-coil type (Tester or like may be used) (Internal resistance 50kΩ or more)	DC0 to 5V/0 to 10V	"5" is common.
	Across 1(+)-5		DC0 to ±5V to 0, ±10V	
	Across 4(+)-5		DC4 to 20mA	
Speed setting power supply	Across 10(+)-5		DC5V	
	Across 10E(+)-5		DC10V	
Meter signal	Across FM(+)-SD		Approx. 5VDC at maximum speed (Without meter)  Pulse width T1: Use Pr. 900 to adjust.	SD is common.
	Across AM(+)-5		Approx. 10VDC at maximum speed	
Start signal Selection signal	Across STF, STR, RH, RM, RL, JOG, RT, AU, STOP, CS(+)-SD		When terminals are open, 20 to 30VDC ON-time voltage 1V max.	
Reset	Across RES(+)-SD			
Output stop	Across MRS(+)-SD			
Alarm signal	Across A-C Across B-C	Moving-coil type (e.g. tester)	Continuity check (*1) <At OFF> <At ON> Across A-C Discontinuity Continuity Across B-C Continuity Discontinuity	

(*1) When the Pr. 195 "A, B, C terminal function selection" setting is positive logic.

7. SPECIFICATIONS

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7.1 Drive Unit Specifications

7.1.1 Standard specifications

(1) Rating specifications

MD-AX520-□□			0.5K	1.0K	1.5K	2.0K	3.5K
Applicable motor capacity (kW)			0.5	1.0	1.5	2.0	3.5
Output	Overload capacity		150% 60s (inverse-time characteristics)				
	Regenerative braking torque	Max. value/time	150% 5s			100% 5s	
		Permissible duty	3%ED				
Power supply	Rated input AC voltage		Three phase, 200V to 220V 50Hz, 200 to 230V 60Hz				
	Permissible AC voltage fluctuation		170 to 242V 50Hz, 170 to 253V 60Hz				
	Permissible frequency fluctuation		±5%				
	Power supply system capacity (kVA)		1.1	2.2	3.1	4.3	7.3
Protective structure			Enclosed type (IP20)				
Cooling system			Self-cooling		Air cooling		
Approx. weight (kg)			2.0	2.5	3.5	3.5	3.5

MEMO	● The rated output capacity and rated speed of the motor used with the drive unit assume the rated input AC voltage indicated above. They cannot be guaranteed when the power supply voltage drops. ● The overload capacity indicated in % is the ratio of the overload current to the motor's rated output. ● The power supply system capacity varies with the values of the power supply side impedances (including those of the input reactor and cables). ● The drive unit cannot run multiple motors.

● **Control specifications**

Control system		Sensor-less PWM control
Carrier frequency		Any of 1.3kHz, 3.8kHz, 6.4kHz and 9.0kHz can be set.
Max. output speed		3000r/min (output frequency 200Hz)
Speed setting resolution	**Analog input**	1/4000 of the max. preset speed (0.15r/min or more)
	Digital input	1r/min
Speed output resolution		0.15r/min
Speed accuracy	**Analog input**	Within ±0.2% of maximum output speed (25°C±10°C)
	Digital input	Within ±0.05% of maximum output speed
Starting torque		150% or more
Speed control range		1 : 20
Initial magnetic pole detection time		Approx. 0.1s (85ms±15ms)
Acceleration/deceleration time setting range		0.08 to 3600s (acceleration and deceleration can be set individually)
Acceleration/deceleration control pattern		Linear or S-shape pattern selectable
Voltage control		Operation speed, operation time
Stall prevention operation level		Operation level 150%, presence or absence selectable

● **Operational specifications**

Operation method	**PU operation**		Operation panel (standard feature) operation, parameter unit (option) operation
	External operation		Operation using external analog/contact signals
	Communication operation		Communication operation using RS-485 8-pole, 8-core modular connector, 1 channel
Terminal functions	**Speed command**		Analog input, 3 channels
		Voltage input	DC0 to 10V/DC0 to 5V
		Current input	DC4 to 20mA
		Auxiliary input	DC0 to ±10V
	Start/stop		Contact input, 3 channels (Forward rotation/stop, reverse rotation/stop, start self-holding selection)
	Reset		Contact input, 1 channel
	Operation function input signal selection		Contact input, 8 channels
		Selection signals	Multi-speed operation (up to 15 speeds), current input selection, JOG operation, second function selection, third function selection, external signal input selection, PU operation external interlock, PID control operation cancel, PU operation/external operation switching, output stop
	Operation status output signal selection		Relay changeover contact output, 1 channel
			Open collector output, 5 channels
		Selection signals	Running, up to speed, instantaneous power failure detection, overload alarm, speed detection (3 points), regenerative brake alarm, electronic overcurrent protection alarm, during PU operation, operation ready, output current detection, PID upper/lower limit, PID forward/reverse rotation, fan failure, fin overheat alarm, fault detection
	Instrument output signal selection		Pulse train output, 1 channel
			Analog output, 1 channel
		Selection signals	Motor speed, motor current, output voltage, preset speed, converter output voltage, regenerative brake duty, electronic overcurrent protection load factor

Operation panel functions	**Operation command**	Start (forward/reverse rotation), stop, JOG by individual key operations
		Speed command by ▲▼ key operation
	Monitor items	Motor speed, motor current, output voltage, alarm display, preset speed, converter output voltage, regenerative brake duty, electronic overcurrent protection load factor, cumulative energization time, actual operation time
	Others	Alarm history storage (4 alarms), read of motor speed, motor current and output voltage immediately before protective function is activated, parameter copy function
Protective functions		Overcurrent (acceleration, deceleration, constant speed), ground-fault overcurrent, overvoltage (acceleration, deceleration, constant speed), overload (electronic overcurrent protection), instantaneous power failure, undervoltage, fin overheat, external protection, PU disconnection, retry count excess, brake transistor alarm, output short circuit, parameter error, output phase failure, CPU error, 24VDC operation power supply output short circuit, operation panel power supply short circuit
Alarm functions		Overload, brake resistor overheat, fan failure

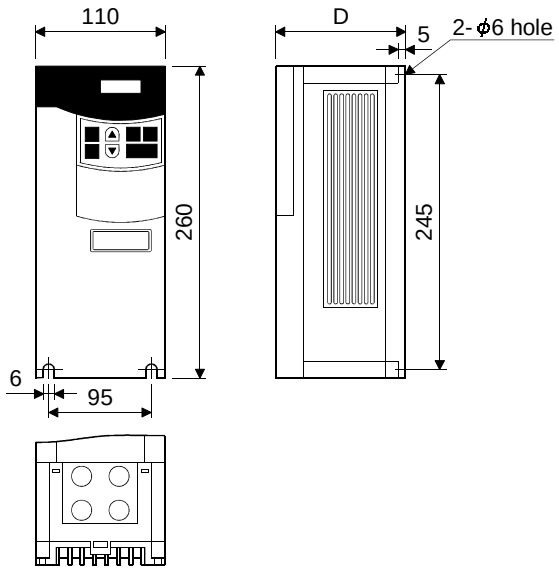
Note: Commercial power supply switching operation cannot be performed.

● **Environmental specifications**

Ambient temperature	-10°C to +50°C (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Storage temperature	-20°C to +65°C (applies to short-time transit, etc.)
Ambience	Indoors. (No corrosive and flammable gases, oil mist, dust and dirt.)
Altitude, vibration	Max. 1000m above sea level, 5.9m/s^2 (conforms to JIS C 0040)

7.1.2 Outline drawings

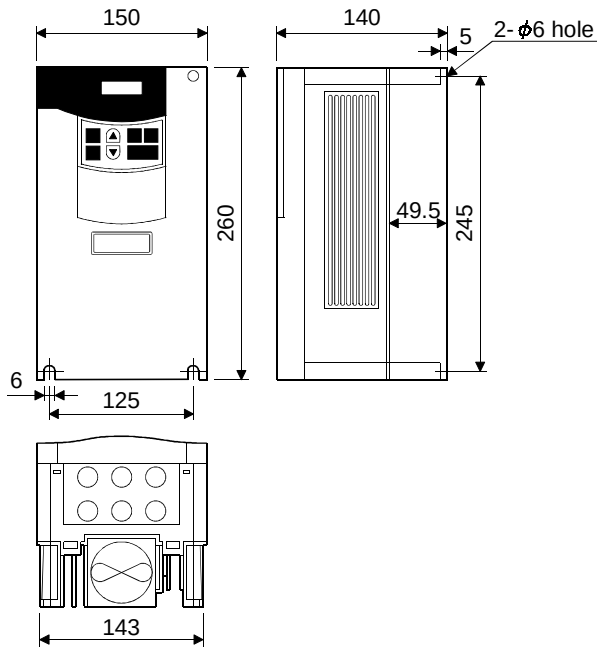
AX520-0.5K, 1.0K



Drive Unit Type	D
0.5K	110
1.0K	125

(Unit: mm)

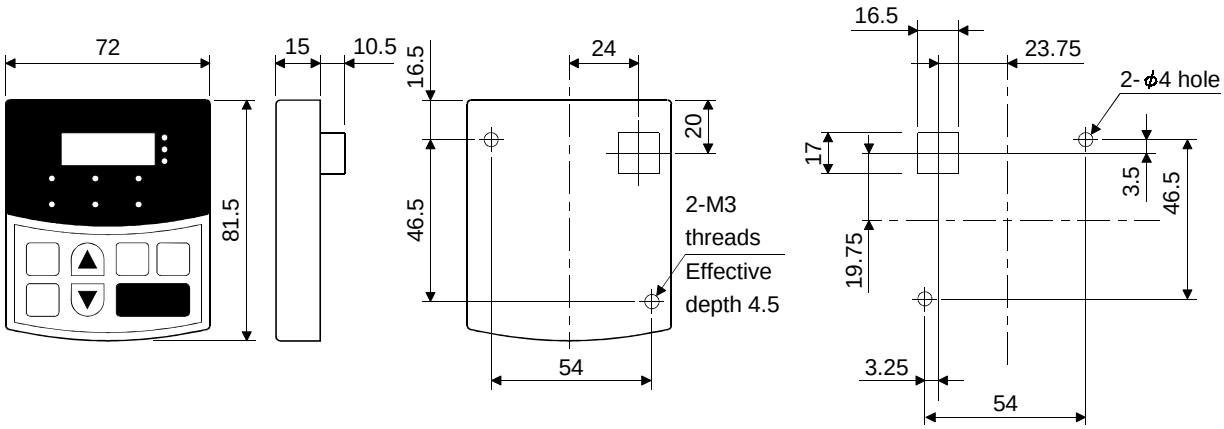
AX520-1.5K to 3.5K



(Unit: mm)

Operation panel

<Outline drawing> **<Panel cutting dimension drawing>**

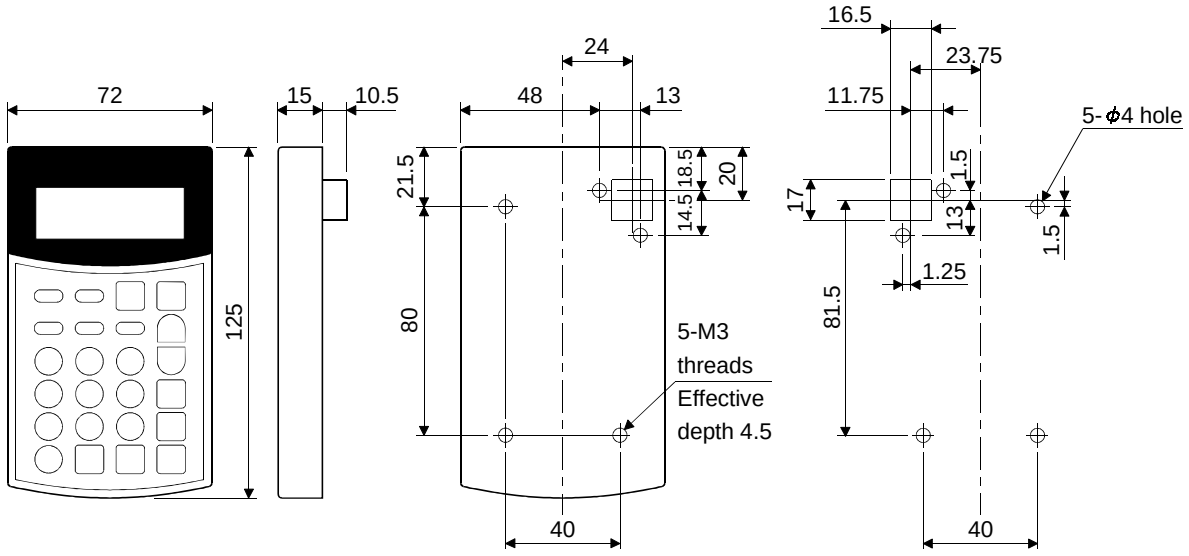


Select the mounting screws so that their length will not exceed the mounting threads' effective depth.

(Unit: mm)

Parameter unit (FR-PU04)

<Outline drawing> **<Panel cutting dimension drawing>**



Select the mounting screws so that their length will not exceed the mounting threads' effective depth.

(Unit: mm)

7.1.3 Option list

	Name	Type	Applicable Capacity	Application, Specifications, Etc.
Stand-alone type	Parameter unit (Japanese only)	FR-PU04	All capacities	LCD display, capable of direct input from ten-key pad. **Refer to: Chapter 4, 4.4 Instructions for Use of the FR-PU04**
	Parameter unit connection cable	FR-CB201 FR-CB203 FR-CB205	All capacities	Cable for connection of the operation panel or parameter unit. Available in three lengths, 1m, 3m and 5m.
	Heat sink external mounting attachment	FR-A5CN01	1.5K or more	Used to place only the heat sink section of the drive unit in the outside of the control box.
	Dirt-protection structure attachment	FR-A5CV01	All capacities	By installing this option, the drive unit meets the totally enclosed structure specifications (IP40).
	Power factor improving DC reactor	FR-BEL-0.4K FR-BEL-0.75K FR-BEL-1.5K FR-BEL-2.2 FR-BEL-3.7K	0.5K 0.1K 1.5K 2.0K 3.5K	Used to improve the input power factor (overall power factor about 95%) and cooperate with the power supply.
	Power factor improving AC reactor	FR-BAL-0.4K FR-BAL-0.75K FR-BAL-1.5K FR-BAL-2.2K FR-BAL-3.7K	0.5K 1.0K 1.5K 2.0K 3.5K	Used to improve the input power factor (overall power factor about 90%) and cooperate with the power supply.
	Radio noise filter	FR-BIF	All capacities	For radio noise reduction. (Leakage current = approx. 4mA)
	Line noise filter	FR-BSF01 FR-BLF	All capacities	For line noise reduction. (Leakage current can be ignored.)
	High-duty brake resistor	FR-ABR-0.4K FR-ABR-0.75K FR-ABR-2.2K FR-ABR-3.7K	0.5K 1.0K 1.5K, 2.0K 3.5K	Used to improve the braking capability of the drive unit. (Permissible duty: 10%ED)
	BU brake unit	BU-1500 BU-3700 BU-7.5K	0.5K, 1.0K 1.5K 2.0K, 3.5K	Used with a discharge resistor to improve the braking capability of the drive unit.
	Discharge resistor	GZG, GRZG	—	Resistor designed for use with the BU brake unit.
	High power factor converter	FR-HC-7.5K	All capacities	Returns regenerative energy from the motor to the power supply.
Controllers	Three speed selector	FR-AT	All capacities	For three-speed (high, middle, low) switching operation.
	Deviation detector	FR-FD		For synchronous operation. Used with a deviation sensor and synchro.
	Master controller	FR-FG		Allows parallel operation of up to 35 drive units.
	Ratio setter	FR-FH		For ratio control. Allows ratios to be set to five drive units.
	Motorized speed setter	FR-FK		For remote operation. Allows operation to be controlled from multiple places.
	PG follower	FR-FP		For follow-up operation using the signal of a pilot generator (PG).
Others	Pilot generator	QVAH-10	All capacities	For follow-up operation.
	Deviation sensor	YVGC-500W-NS		For synchronous operation (mechanical deviation detection).
	Speed setting potentiometer	WA2W1kΩ		For speed setting. Wire-wound type. 2W, 1kΩ, B characteristic.

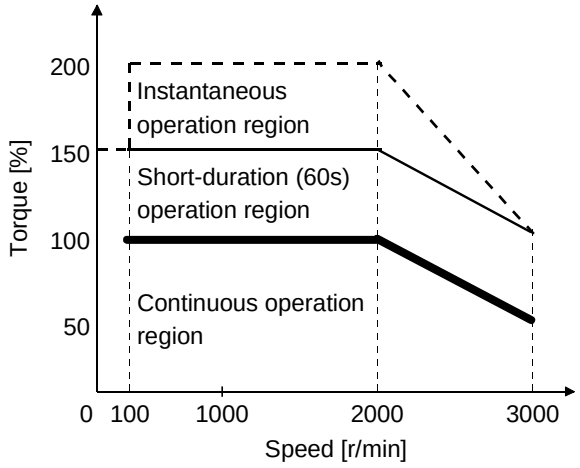
7.2 Motor Specifications

7.2.1 Standard specifications

Item \ Motor		2000r/min Series				
		MM-CF52	MM-CF102	MM-CF152	MM-CF202	MM-CF352
Compatible drive unit	MD-AX520-□□□ MD-CX520-□□□	0.5K	1.0K	1.5K	2.0K	3.5K
Continuous characteristics (Note 1)	Rated output [kW]	0.5	1.0	1.5	2.0	3.5
	Rated torque [N•m]	2.39	4.78	7.16	9.55	16.70
Rated speed (Note 1) [r/min]		2000				
Maximum speed [r/min]		3000				
Permissible instantaneous speed [r/min]		3450				
Maximum torque [N•m]		4.78	9.56	14.32	19.09	33.41
Inertia moment J [$\times 10^{-4}$kg•m^2]		6.6	13.7	20.0	45.5	85.6
Permissible ratio of load inertia moment to motor shaft inertia moment (Note 2)		100 times max.			50 times max.	
Rated current [A]		1.81	3.70	5.22	7.70	12.50
Insulation class		Class F				
Structure		Totally closed, self-cooling (protection system: IP44 (Note 3))				
Environmental conditions (Note 4)	Ambient temperature	-10°C to +40°C (non-freezing)				
	Ambient humidity	90%RH or less (non-condensing)				
	Storage temperature	-20°C to +70°C (non-freezing)				
	Storage humidity	90%RH or less (non-condensing)				
	Ambience	Indoors (no exposure to direct sunlight), no corrosive and flammable gases, oil mist, dust and dirt.				
	Altitude	Max. 1000m above sea level				
	Vibration	X: 9.8m/s^2, Y: 24.5m/s^2				
Weight [kg]		5.1	7.2	9.3	13.0	19.0

Note 1. When the power supply voltage drops, the output and rated speed cannot be guaranteed.
2. This value assumes that the load torque is about 20% of the rated motor torque. If the load torque is larger, the permissible ratio of load inertia moment to motor shaft inertia moment is smaller. Consult Mitsubishi if the ratio of load inertia moment to motor shaft inertia moment exceeds the indicated value.
3. Except the shaft through portion.
4. When the motor is to be operated in a place where it will be exposed to oil and/or water, e.g. machine field, consult us since a motor of optional features is needed.

Torque characteristics

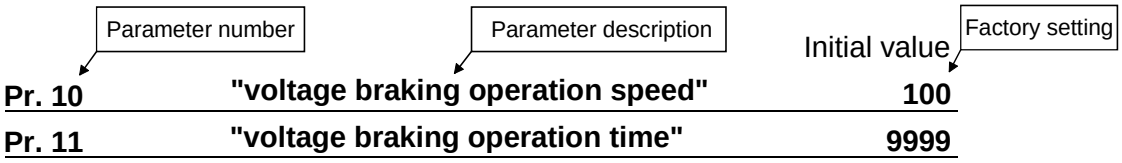


8 PARAMETER FUNCTIONS

Refer to Appendix 1 for the parameter list.

This chapter describes the parameter functions of the drive unit.
The parameters are basically explained in the following format.

Example: Pr. 10, 11



Pr.	Setting Range	Unit	Operation
10	0 to 200	r/min	At the preset speed or less, the motor is stopped by voltage braking.
11	0.0 to 60.0	s	Set the voltage braking time. Setting 0 coasts the motor to a stop at the Pr. 10 setting or less.
	9999	—	The voltage braking time (0 to 3s) is adjusted automatically.

● The minimum increment of the setting is 0.1 in the setting range 0.0 to 60.0, or 1 in the range 0 to 60.
● The value having a 0 on the right of the decimal point can be entered as an integer.
(Example: 10.0 → 10)

MEMO	● If any parameter cannot be set, check that: • The start signal (STF or STR) is not "ON". • The parameter write disable selection (Pr. 77) setting has not been made. • The PU operation mode has not been selected. ● When the PU operation mode cannot be selected, check that: • The start signal (STF or STR) is not "ON". • The operation mode selection (Pr. 79) setting is not other than "0".

Contents of This Chapter

The parameters marked BASIC are the basic operation parameters.

Refer to: Chapter 5, 5.2.2 Confirmation of the basic operation parameters

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8.1 Protection and Editing of the Parameters

		Initial value
Pr. 77	**"parameter write disable selection"**	**0**

You can select between write-enable and disable for parameter setting.

Setting	Function	Exceptional Parameters
0	You can change the setting only during a stop in the PU operation mode.	Even during operation, you can change the values of the parameters whose numbers are shaded in the parameter list in Appendix 1. However, Pr. 72 allows its setting to be changed in the PU operation mode only.
1	Whether the motor is running or at a stop, you cannot change the settings in any operation mode. Parameter clear, parameter all clear and user clear operations are also disabled.	Pr. 22 [Section 8.5.6], Pr. 75 [Section 8.2], Pr. 77, Pr. 79 [Section 8.2], and Pr. 188 [Section 8.4] allow their values to be changed in any operation mode.
2	Whether the motor is running or at a stop, you can change the values in any operation mode.	Pr. 79 [Section 8.2], Pr. 180 to 187, Pr. 189 [Section 8.4], and Pr. 190 to 195 [Section 8.7.2] allow their values to be changed during a stop only.

		Initial value
Pr. 160	**"user group read selection"**	**0**
Pr. 173	**"user group 1 registration"**	**0**
Pr. 174	**"user group 1 deletion"**	**0**
Pr. 175	**"user group 2 registration"**	**0**
Pr. 176	**"user group 2 deletion"**	**0**

From among all parameters, a total of 32 parameters can be registered to two different user groups. The registered parameters may only be accessed for reading and writing.

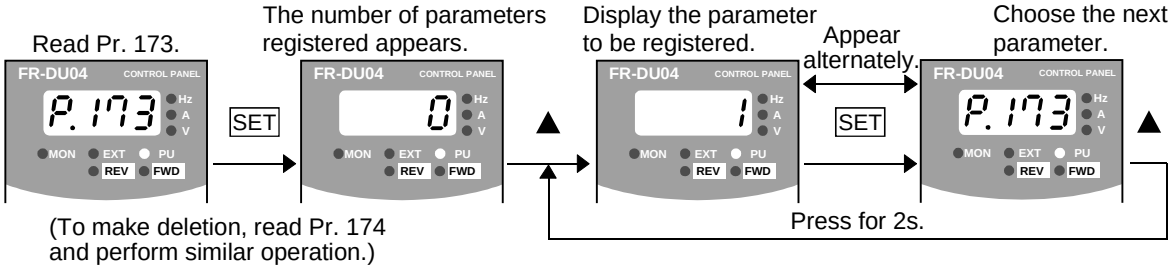
● By setting the required value in Pr. 160, make the user groups valid or invalid.

Setting	Description
0	User groups are made invalid and all parameters can be accessed for read and write.
1	Only the parameters registered to user group 1 can be accessed for read and write.
10	Only the parameters registered to user group 2 can be accessed for read and write.
11	Only the parameters registered to user groups 1 and 2 can be accessed for read and write.

● Using Pr. 173 to Pr. 176, register or delete the parameters to the user groups.

	Pr.	Setting Range	Description
User group 1	173	0 to 999	The parameter number to be registered is written as a set value.
	174	0 to 999	The parameter number to be deleted is written as a set value.
		9999	Written when the registered parameters are all to be deleted.
User group 2	175	0 to 999	The parameter number to be registered is written as a set value.
	176	0 to 999	The parameter number to be deleted is written as a set value.
		9999	Written when the registered parameters are all to be deleted.

Key operation method (when registering Pr. 1 to the user group [Section 8.5.1])



MEMO	● The Pr. 77, Pr. 160 and Pr. 991 values can always be accessed for read and write independently of the Pr. 160 setting. ● "0" set in the second digit of the two-digit Pr. 160 setting is not displayed. However, it is displayed when "0" is set in the first digit only.

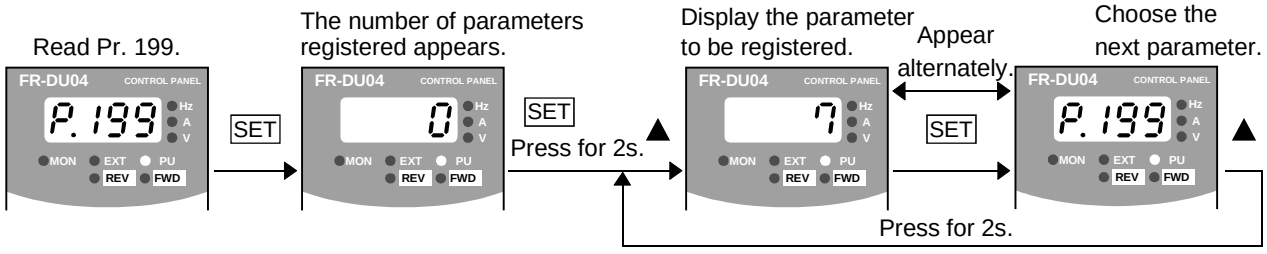
Initial value

Pr. 199 "user's initial value setting" 0

You can change the initial parameter values from the factory settings to user settings. These values may be set to 16 parameters.
By performing user clear operation from the operation panel or FR-PU04 parameter unit, you can change the parameters to the user-set initial values.

Setting Range	Description
0 to 999	The parameter number whose initial value is to be changed to a user-set value is written.
9999	The registered user initial values are batch-deleted.

Key operation method (when registering Pr. 7 [Section 8.5.2])



MEMO	● Each of the initial values of Pr. 902 to Pr. 905 [Section 8.3.1] uses the area of two parameters for registration. ● You cannot change the initial values of the parameters which cannot be cleared.

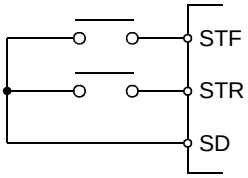
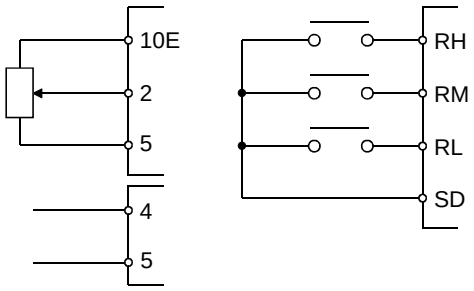
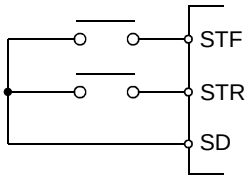
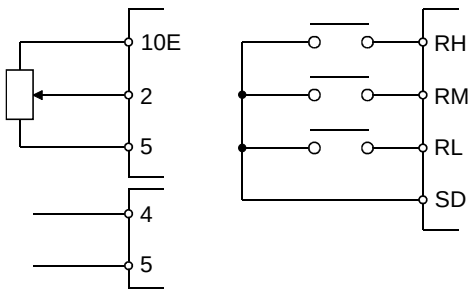
8.2 Selection of the Operation Mode

Pr. 79	"operation mode selection"	Initial value 0

The setting range is 0 to 4 and 6 to 8.

● When the operation mode is fixed (Setting 0 to 4)

Setting	Mode	Function (Refer to: Chapter 5, 5.3 Operation Examples)
0	PU/external operation switching	You can perform operation by changing between the PU operation mode and external operation mode from the operation panel or parameter unit (FR-PU04). The unit is placed in the external operation mode at power-on.
1	PU operation	The PU operation mode is made valid.
2	External operation	The external operation mode is made valid.
3	External/PU combined operation 1	The external/PU combined operation mode 1 is made valid.
4	External/PU combined operation 2	The external/PU combined operation mode 2 is made valid.

Operation Mode	Input of Start Signal	Input of Speed Setting Signal
PU operation mode (when using operation panel)	From operation panel FWD REV STOP/RESET	From operation panel ▲ ▼
External operation mode	From control circuit terminals 	From control circuit terminals 
External/PU combined operation 1 (when using operation panel)	From control circuit terminals 	From operation panel ▲ ▼ Multi-speed input is also enabled from control circuit terminals.
External/PU combined operation 2 (when using operation panel)	From operation panel FWD REV STOP/RESET	From control circuit terminals 

● When the operation mode switching condition is specified (Setting 6 to 8)

Setting	Mode	Function
6	Switch-over	In response to the selection of the PU operation mode or external operation mode from the operation panel or parameter unit (FR-PU04), the operation command right can be changed from the external operation to the PU operation or from the PU operation to the external operation without stopping the operation.

The operation in the switch-over mode is performed as described in the following table.

Operation Mode Switching	Switching Control/Operation Status
External operation → PU operation	● The operation mode is switched to the PU operation mode. • The rotation direction remains unchanged from the direction of the external operation. • The speed remains unchanged from the setting of the external operation. (Once power is switched "OFF" or a reset is made, the stored setting of the external operation is cleared to "0" and the operation stops.)
PU operation → external operation	● The operation mode is switched to the external operation mode. • The rotation direction is determined by the input signal of the external operation. • The speed is determined by the external setting signal.

Setting	Mode	Function
7	PU operation interlock	When the contact input terminal for the X12 signal has been selected is "OFF", the operation mode is fixed to the external operation mode. To switch it to the PU operation mode, turn "ON" the X12 signal and change the operation mode from the operation panel. Turning the X12 signal "OFF" automatically returns the operation mode to the external operation mode. When the X12 signal is not selected, the MRS terminal acts as the terminal having the function of the X12 signal. **Refer to: 8.4 Selection of the Control Circuit Contact Input Terminal Functions**

1) Change of operation status when X12 signal is turned from "OFF" to "ON"

Operation Status When X12 Signal = "OFF"		Operation Status After X12 Signal = "ON"	
PU operation mode	Operation disabled	PU operation mode	Operation enabled by control exercised in PU operation mode.
External operation mode	During stop	External operation mode	During stop
	During operation		Output stop

2) Change of operation status when X12 signal is turned from "ON" to "OFF"

Operation Status When X12 Signal = "ON"		Operation Status After X12 Signal = "OFF"	
PU operation mode	During stop	External operation mode	During stop
	During operation		Operation is performed in accordance with the speed setting and start signal of the external operation if they are input.
External operation mode	Operation disabled		Operation is performed in accordance with the speed setting and start signal of the external operation if they are input.

Setting	Mode	Function
8	External signal switching	When the contact input terminal where the X16 signal has been selected is "ON", the operation mode is fixed to the external operation mode, or when that terminal is "OFF", the operation mode is fixed to the PU operation mode. Switching is enabled during a stop only. **Refer to: 8.4 Selection of the Control Circuit Contact Input Terminal Functions**

MEMO	● If the X12 signal is "ON" in the PU operation interlock mode, the operation mode cannot be changed to PU operation when the start signal (STF, STR) is "ON". Switching to external operation is independent of "ON"/"OFF" of the start signal. When the X12 signal is turned "OFF" with the start signal "ON", operation is performed in accordance with the external operation command. ● When the MRS terminal is used as the X12 signal, the signal logic change set in Pr. 17 [Section 8.4] is valid. ● When using the unit in the communication operation mode from the PU connector, change the operation mode through communication. You need not set Pr. 79. **Refer to: 8.6.2 Communication operation from PU connector**

Initial value

Pr. 75 "disconnected PU detection/PU stop selection" 0

● Disconnected PU detection function

You can make selection between continued operation or an alarm stop ("E. PUE" indication) when the operation panel or FR-PU04 parameter unit has come off the drive unit during operation.

MEMO	● This function is invalid if power is switched on with the operation panel or FR-PU04 parameter unit removed.

● PU stop selection

Select the operation mode in which an operation stop is made valid by the STOP/RESET key of the operation panel or FR-PU04 parameter unit.

Setting	PU Disconnection Detection Function	PU Stop Selection Operation Mode
0	Operation continued.	Any operation mode. When operation is stopped in the external operation mode or PU/external combined operation mode 1, "PS" appears in the main indicator LED. No alarm signal is output.
1	Alarm stop.	
2	Operation continued.	PU operation mode, PU/external combined operation mode 2.
3	Alarm stop.	

Restarting method when "PS" appears in the main indicator LED

To restart operation, turn "OFF" the operation command (STF or STR) signal, perform the following operation, and then turn "ON" the operation command.

(1) When using the operation panel

1) Press the MODE key of the operation panel three times to display the external operation mode screen ("OP.nd" indication).
   When Pr. 79 = 3, press the MODE key three times, then press the ▲▼ key.
2) Press the SET key.

(2) When using the FR-PU04 parameter unit

1) Press the EXT key.

MEMO	● In the communication operation mode, the PU disconnection detection function is invalid. ● Pr. 75 does not return to the initial value if parameter clear or all clear [Section 4.3] is performed.

8.3 Selection of the Speed Command

8.3.1 Selection of the analog speed command specifications

		Initial value
Pr. 73	**"speed command range selection"**	**0**

You can select the specifications of the speed command input terminals, forward/reverse rotation operation according to the input signal polarity, and the override function.
When using the terminal 2 only, set "0" or "1" ("10" or "11" for polarity reversible operation) in this parameter. This function can be used with other speed command terminals.

(1) When terminal 2 is used for main speed, terminal 1 for auxiliary speed, and these signals are added for use as speed command

Setting	Terminal 2 Input Voltage	Terminal 1 Input Voltage	Polarity Reversible Operation	AU Signal
0	0 to 10V	0 to ±10V	Operation is stopped when the result of addition is a negative value.	Turn "OFF" the contact input terminal where the AU signal has been selected [Section 8.4].
1	0 to 5V			
2	0 to 10V	0 to ±5V		
3	0 to 5V			
10	0 to 10V	0 to ±10V	Reverse operation is performed when the result of addition is a negative value.	
11	0 to 5V			
12	0 to 10V	0 to ±5V		
13	0 to 5V			

(2) When terminal 4 is used for main speed, terminal 1 for auxiliary speed, and these signals are added for use as speed command

Setting	Terminal 4 Input Voltage	Terminal 1 Input Voltage	Polarity Reversible Operation	AU Signal
0	4 to 20mA	0 to ±10V	Operation is stopped when the result of addition is a negative value.	Turn "ON" the contact input terminal where the AU signal has been selected [Section 8.4].
1				
2		0 to ±5V		
3				
10		0 to ±10V	Reverse operation is performed when the result of addition is a negative value.	
11				
12		0 to ±5V		
13				

(3) When the main speed of terminal 1 is compensated for by the values set in Pr. 252 and Pr. 253 from terminal 2 and the result is used as speed command

Setting	Terminal 1 Input Voltage	Terminal 2 Input Voltage	Polarity Reversible Operation	AU Signal
4	0 to ±10V	0 to 10V	Operation is stopped when the main speed signal is a negative value.	Turn "OFF" the contact input terminal where the AU signal has been selected [Section 8.4].
5	0 to ±5V	0 to 5V		
14	0 to ±10V	0 to 10V	Reverse operation is performed when the main speed signal is a negative value.	
15	0 to ±5V	0 to 5V		

(4) When the main speed of terminal 4 is compensated for by the values set in Pr. 252 and Pr. 253 from terminal 2 and the result is used as speed command

Setting	Terminal 4 Input Voltage	Terminal 2 Input Voltage	AU Signal
4	4 to 20mA	0 to 10V	Turn "ON" the contact input terminal where the AU signal has been selected [Section 8.4].
5		0 to 5V	

		Initial value
Pr. 74	**"filter time constant"**	**1**

You can set the filter time constants of the speed command input terminals (terminals 2, 1, 4). Increase the value if stable operation cannot be performed due to the influence of noise on the speed command signal. Decreasing the value makes the speed command signal more susceptible to noise but the response of the speed command faster. Conversely, increasing the value makes the speed command signal less susceptible to noise but the response of the speed command slower.

Setting
0 to 8

		Initial value
Pr. 252	**"override bias"**	**50**
Pr. 253	**"override gain"**	**150**

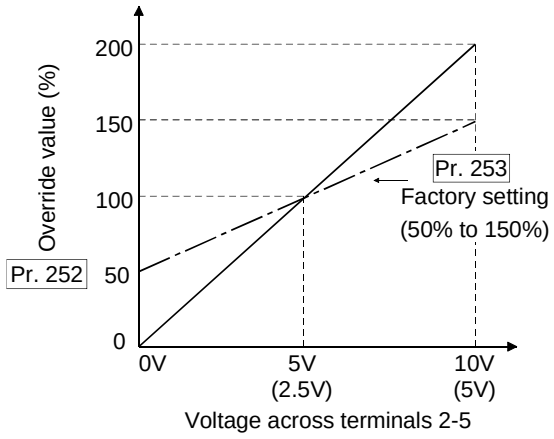
Speed compensation of a given ratio is made for the main speed setting signal.
The relationship between the compensation speed and override value is as indicated below.

$$\text{Compensation speed} = \text{pre-compensation speed} \times \frac{\alpha}{100}\ (\text{r/min})$$

α: Override value (%)

Use Pr. 74 when the Pr. 73 setting is any of 4, 5, 14 and 15.

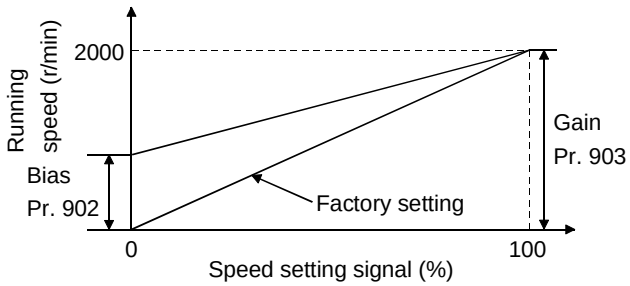
Parameter Number	Setting Range	Unit
252	0.0 to 200.0	%
253	0.0 to 200.0	%



		Initial value
Pr. 902	**"speed setting voltage bias"**	**Approx. 0/0**
Pr. 903	**"speed setting voltage gain"**	**Approx. 100/2000**

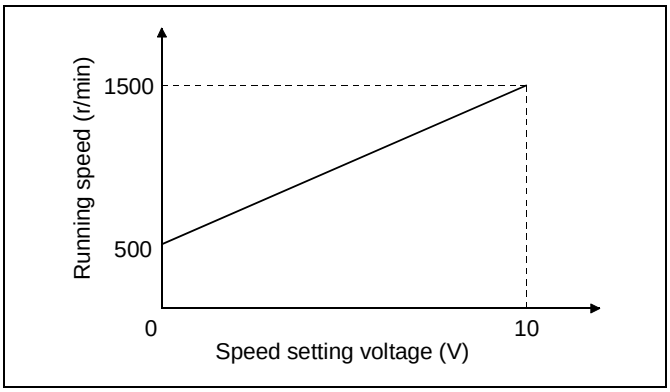
You can set the relationship between the magnitude of the speed setting analog voltage signal input to the terminal 2 and the motor speed. 0V of the speed setting signal corresponds to approx. 0%, and 5V or 10V (depending on Pr. 73 setting) to approx. 100%.

Pr.	**Setting Range**			
	Motor speed	**Unit**	**Speed setting signal**	**Unit**
902	0 to 2000	r/min	0.0 to 300.0	%
903	1 to 3000		0.0 to 300.0	

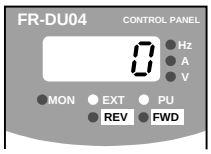
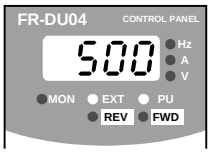
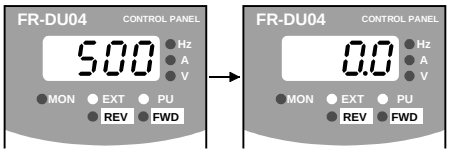
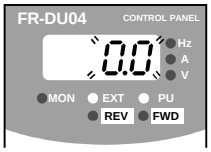
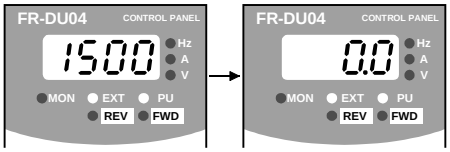
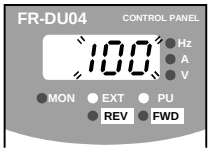


<Setting example 1>

Set 500r/min at the speed setting signal 0V and 1500r/min at 10V.

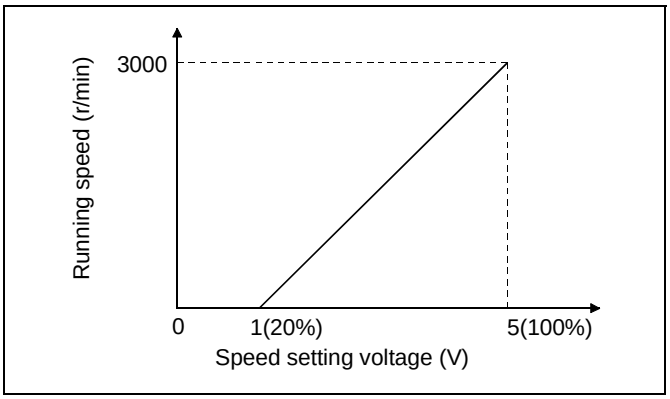


Make sure that 0-10V is selected as the input voltage of the terminal 2. (Pr. 73 = 0)

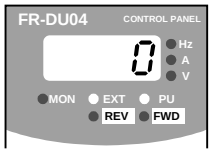
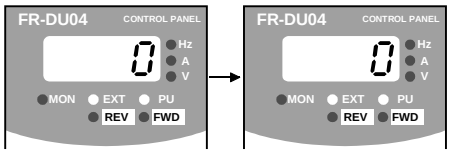
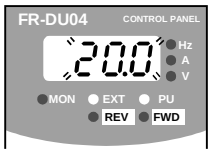
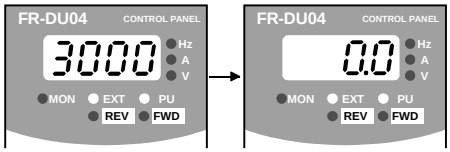
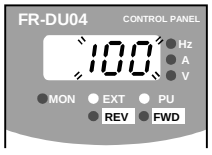
Item	Operation Procedure	Operation Panel Screen (on Completion of Operation)
Bias setting	1) Set the operation mode to the PU/external combined mode 2 (Pr. 79 = 4 [Section 8.2]) and read Pr. 902.	 Initial value 0 appears.
	2) Set the running speed 500 with the ▲▼ key.	
	3) Hold down the SET key until the displayed value turns to a % equivalent for the terminal 2 input voltage. (About 2s)	 For input voltage 0V
	4) Set the speed setting signal 0 with the ▲▼ key, or set the terminal 2 input voltage to 0V. Hold down the SET key until the set value flickers. (About 2s)	 Flicker
Gain setting	1) Read Pr. 903.	 Initial value 2000 appears.
	2) Set the running speed 1500 with the ▲▼ key. Hold down the SET key until the displayed value changes. (About 2s)	 For input voltage 0V
	3) Set 100 with the ▲▼ key, or enter 10V into the terminal 2. Hold down the SET key until the set value flickers. (About 2s)	

<Setting example 2>

Set 0r/min at the speed setting signal 1V and 3000r/min at 5V.



Make sure that 0-5V is selected as the input voltage of the terminal 2. (Pr. 73 = 1)

Item	Operation Procedure	Operation Panel Screen (on Completion of Operation)
Bias setting	1) Set the operation mode to the PU/external combined mode 2 (Pr. 79 = 4 [Section 8.2]) and read Pr. 902.	 Initial value 0 appears.
	2) Set the running speed 0 with the ▲▼ key, and hold down the SET key until the displayed value turns to a % equivalent for the terminal 2 input voltage. (About 2s)	 For input voltage 0V
	3) Set 20 with the ▲▼ key or enter 1V into the terminal 2. Hold down the SET key until the set value flickers. (About 2s)	
Gain setting	1) Read Pr. 903.	 Initial value 2000 appears.
	2) Set the running speed 3000 with the ▲▼ key, and hold down the SET key until the displayed value changes. (About 2s)	 For input voltage 0V
	3) Set 100 with the ▲▼ key, or enter 5V into the terminal 2. Hold down the SET key until the set value flickers. (About 2s)	

		Initial value
Pr. 904	**"speed setting current bias"**	**Approx. 20/0**
Pr. 905	**"speed setting current gain"**	**Approx. 100/2000**

You can set the relationship between the magnitude of the speed setting analog current signal input to the terminal 4 and the motor speed. 0mA of the speed setting signal corresponds to approx. 0%, and 20mA to approx. 100%.

Pr.	Setting Range			
	Motor speed	**Unit**	**Speed setting signal**	**Unit**
904	0 to 2000	r/min	0.0 to 300.0	%
905	1 to 3000		0.0 to 300.0	

You can set these parameter values as when you set the speed setting voltage bias and gain in Pr. 902 and Pr. 903.

8.3.2 Variable-speed operation using contact input signals

		Initial value
Pr. 4	**"three-speed setting (high speed)"**	**2000**
Pr. 5	**"three-speed setting (middle speed)"**	**1000**
Pr. 6	**"three-speed setting (low speed)"**	**500**
Pr. 24 to 27	**"multi-speed setting (speed 4 to 7)"**	**9999**
Pr. 232 to 239	**"multi-speed setting (speed 8 to 15)"**	**9999**

Pr.	Setting Range	Unit
4 to 6	0 to 3000	r/min
24 to 27	0 to 3000	
232 to 239	9999	—

Combining "ON"/"OFF" of the contact signals to the terminals RH, RM, RL and CS allows you to choose the preset running speed (any of up to 15 different speeds).
Selecting the control circuit contact input terminal functions enables use of the other terminals.

Refer to: 8.4 Selection of the Control Circuit Contact Input Terminal Functions

The following table lists the relationships between the contact signal input combinations and running speeds.

Speed	Contact Signal Input				Running Speed Setting Parameter	Remarks
	REX	RH	RM	RL		
Speed 1	OFF	ON	OFF	OFF	Pr. 4	When two or more contact signals are "ON", priority is given to the signals in order of terminals RL, RM and RL.
Speed 2	OFF	OFF	ON	OFF	Pr. 5	
Speed 3	OFF	OFF	OFF	ON	Pr. 6	
Speed 4	OFF	OFF	ON	ON	Pr. 24	When performing multi-speed operation at speeds 4 and higher, set the running speeds in the corresponding parameters. When "9999" is set in the parameter, input of the corresponding signal performs operation at the lower preset speed.
Speed 5	OFF	ON	OFF	ON	Pr. 25	
Speed 6	OFF	ON	ON	OFF	Pr. 26	
Speed 7	OFF	ON	ON	ON	Pr. 27	
Speed 8	ON	OFF	OFF	OFF	Pr. 232	
Speed 9	ON	OFF	OFF	ON	Pr. 233	
Speed 10	ON	OFF	ON	OFF	Pr. 234	
Speed 11	ON	OFF	ON	ON	Pr. 235	
Speed 12	ON	ON	OFF	OFF	Pr. 236	
Speed 13	ON	ON	OFF	ON	Pr. 237	
Speed 14	ON	ON	ON	OFF	Pr. 238	
Speed 15	ON	ON	ON	ON	Pr. 239	

MEMO

- Simultaneous input of the multi-speed operation signal and analog speed signal (across terminals 2-5, 4-5) gives priority to the multi-speed operation signal.
- This function cannot be used with the remote setting function.
- Any setting less than the Pr. 13 value will be a stop (0r/min) setting.

Refer to: 8.5.1 Running speed region

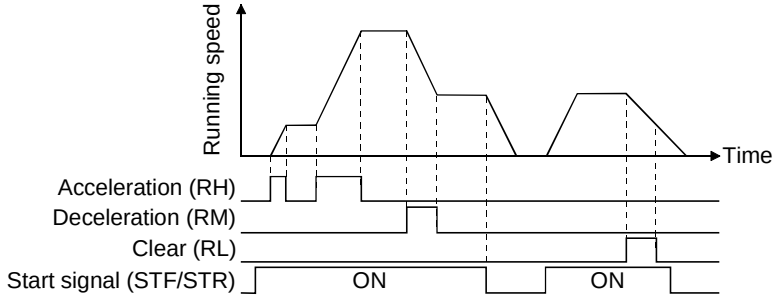
Initial value

Pr. 59 "remote setting function selection" 0

You can perform operation by changing the speed continuously with only the contact signals without using the analog speed signal.

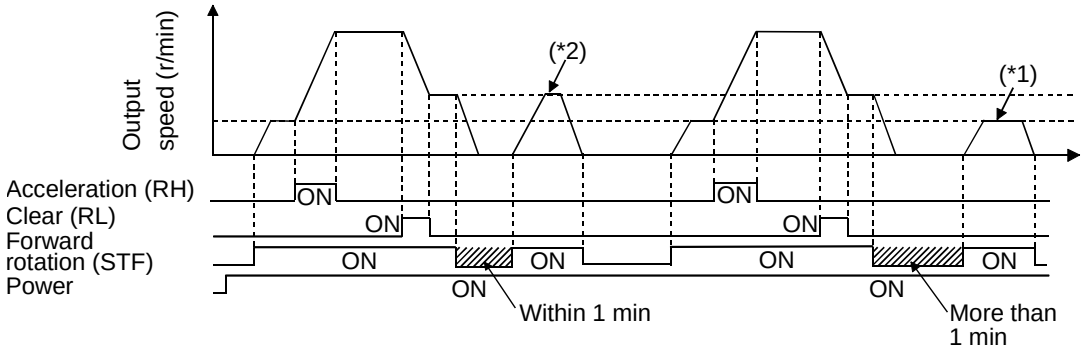
Setting	Function	
	Remote setting function	Speed setting storage function
0	No	—
1	Yes	Yes
2	Yes	No

- When "Yes" is selected for the remote setting function, the terminals assigned to the RH, RM and RL signals in Pr. 180 to 187 "8.4 Selection of the Control Circuit Input Terminal Functions" provide the acceleration, deceleration and clear functions.
- While the RH signal is "ON", the speed increases according to the preset acceleration time. While the RM signal is "ON", the speed decreases according to the preset deceleration time.
- When "Yes" is selected for the speed setting storage function, the running speed at the time when the start signal (STF or STR) is turned "OFF" is stored. If the start signal is not turned "OFF", the running speed more than 1 minute after the RH or RM signal is turned "OFF" is stored.
- When the running speed has been stored, merely switching power on again and inputting the start signal starts operation at the stored running speed.
- Turning "ON" the RL signal clears the stored speed and decelerates the motor to a stop.
- Controlling the RH/RM signal with the start signal "OFF" varies the preset speed.
- When the acceleration or deceleration signal turns ON, the preset speed varies according to the slope set in Pr. 44 or 45 [Section 8.5.2]. The acceleration/deceleration times of the output speed are as set in Pr. 7 and 8 [Section 8.5.2]. Therefore, the actual output speed varies at the longer preset times.
- The speed can be added to the preset speed other than the multi-speed.



MEMO

- When the RH and RM signals are both "ON", the speed does not vary.
- The RL signal is valid only when the RH or RM signal is "OFF".
- After the clear signal (RL) has turned from ON to OFF, a restart should be made (STF signal turned ON) often more than 1 min has elapsed. The output speed provided when a restart made within 1 min is the output speed given after the clear signal (RL) has turned OFF (multi-speed).



(*1) External operation speed or PU operation speed other than multi-speed

(*2) Multi-speed

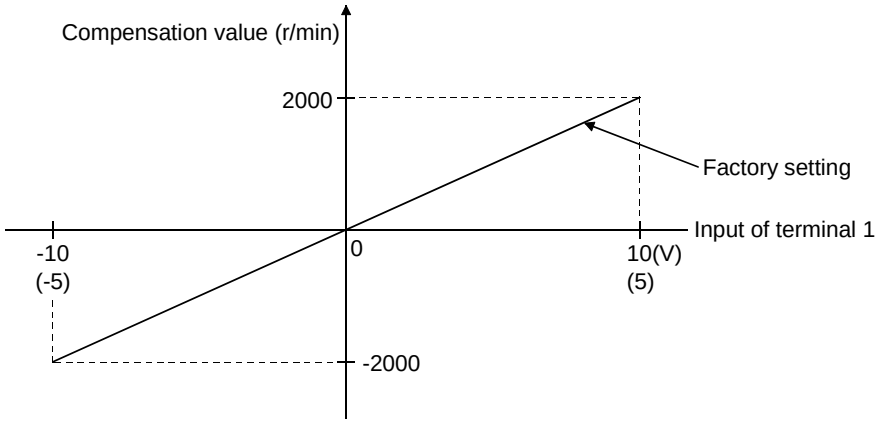
Initial value

Pr. 28 "contact input speed compensation" 0

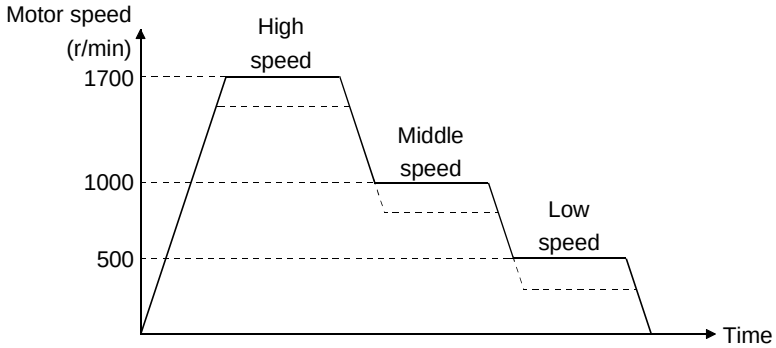
Using the analog speed command, you can compensate for (increment/decrement) the speed set by the contact input provided with the multi-speed setting or remote setting function.

Setting	Function
0	Without speed compensation
1	With speed compensation

1) A given speed is added to the corresponding speed for compensation.
Set any of 0 to 3 in Pr. 73 [Section 8.3.1]. Enter the speed compensation signal to the terminal 1.
The relationship between the input and compensation values of the terminal 1 can be set in Pr. 902 and Pr. 903 [Section 8.3.1].



When multi-speed operation (3 speeds) is performed with the input of 1V (compensation value 200r/min) to the terminal 1 (three-speed settings: high speed 1500r/min, middle speed 800r/min, low speed 300r/min)



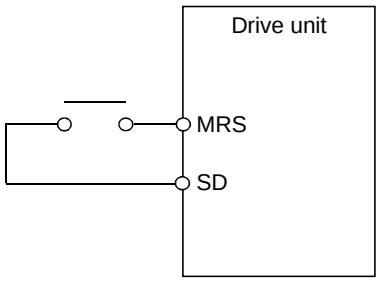
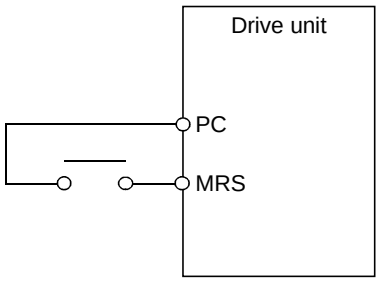
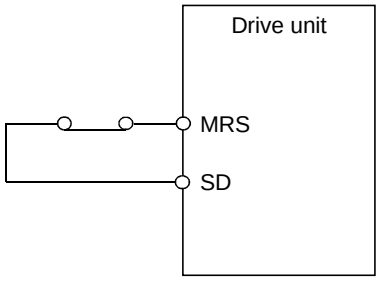
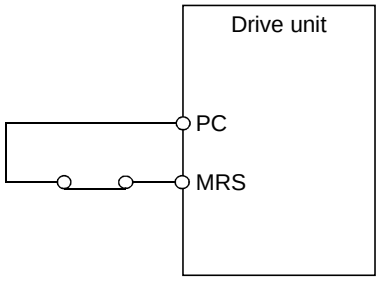
MEMO	● The stop command is given if the polarity of the speed compensation value is negative as a result of compensation. To reverse the rotation with a negative speed command value, set any of 10 to 13 in Pr. 73.

2) The corresponding speed is overridden at a given ratio for compensation.
Set 4 or 5 in Pr. 73. Enter the speed compensation signal into the terminal 2.
The relationship between the input and compensation values of the terminal 2 can be set in Pr. 252 and Pr. 253 [Section 8.3.1].

8.4 Selection of the Control Circuit Contact Input Terminal Functions

		Initial value
Pr. 17	**"MRS input selection"**	**0**

Select the operation logic of the MRS signal assigned to the control circuit terminal.

Setting	Function	Wiring Examples	
		Sink logic	**Source logic**
0	Output shut off when terminals are closed.		
2	Output shut off when terminals are opened.		

		Initial value
Pr. 180	**"RL terminal function selection"**	**0**
Pr. 181	**"RM terminal function selection"**	**1**
Pr. 182	**"RH terminal function selection"**	**2**
Pr. 183	**"RT terminal function selection"**	**3**
Pr. 184	**"AU terminal function selection"**	**4**
Pr. 185	**"JOG terminal function selection"**	**5**
Pr. 186	**"CS terminal function selection"**	**8**
Pr. 187	**"MRS terminal function selection"**	**24**

By setting the corresponding parameter values, you can select/change the functions of the control circuit contact input terminals.
The following table lists the values and functions that may be set to the parameters.

Setting	Signal Name	Function
0	RL	Operation using multi-speed (speeds 1 to 7) setting or remote setting function **Refer to: 8.3.2 Variable-speed operation using contact input signals**
1	RM	
2	RH	
3	RT	Second function **Refer to: 8.5.2 Acceleration time and deceleration time**
4	AU	Selection of current input speed command **Refer to: 8.3.1 Selection of the analog speed command specifications**
5	JOG	JOG operation mode selection **Refer to: 8.6.1 JOG operation**
7	OH	The "external fault" protective function is activated when the external contact connected across terminals OH-SD "opens". **Refer to: Chapter 6, 6.1.1 Protective function activated**
8	REX	Operation using multi-speed (speeds 8 to 15) setting **Refer to: 8.3.2 Variable-speed operation using contact input signals**
9	X9	Third function **Refer to: 8.5.2 Acceleration time and deceleration time**
10	X10	For connection of high power factor converter
12	X12	PU operation external interlock **Refer to: Pr. 79 [Section 8.2]**
14	X14	PID control operation cancel **Refer to: 8.6.3 PID control operation**
16	X16	PU operation-external operation switching **Refer to :Pr. 79 [Section 8.2]**
24	MRS	Same function as that of the contact input terminal MRS. **Refer to: Chapter 3, 3.3.1 Terminals**
9999	—	No function

MEMO	● When the remote setting function (Pr. 59 = 1, 2 [Section 8.3.2]) has been set, the RL, RM and RH terminals provide the remote setting function. ● You can assign one function to two or more terminals. In this case, the function is performed by the logical add of the terminal inputs. ● The priority of the speed commands is in order of JOG, multi-speed operation, current input (AU) operation, and voltage input operation.

Initial value

Pr. 188 "RES terminal operation selection" 0

Select the reset operation of the RES terminal. Reset operation is performed when RES-SD (sink logic) are shorted more than 0.1s.

Setting	Name	Function
0	CPU reset	The cumulative thermal value of the electronic overcurrent protection and the retry count [Section 6.1.1] stored during operation are initialized. The alarm status is canceled. Performing reset operation during operation coasts the motor, and canceling the reset restarts the motor.
1	Alarm/ CPU reset	The alarm status is canceled. At this time, the cumulative thermal value of the electronic overcurrent protection and the retry count are also initialized. A reset input is not accepted during normal operation.

MEMO	● The reset operation performed using the STOP/RESET key of the operation panel or FR-PU04 parameter unit will result in an alarm reset regardless of the Pr. 188 setting. ● The Pr. 188 setting does not return to the initial value if parameter clear or all clear [Section 4.3] is performed.

Initial value

Pr. 189 "STF, STR terminal operation selection" 0

You can turn the terminal STF into a start/stop function and the terminal STR into a direction of rotation direction switching function.

Setting	Forward Rotation Operation		Reverse Rotation Operation		Stop	
	STF	STR	STF	STR	STF	STR
0	ON	OFF	OFF	ON	OFF	OFF
					ON	ON
1	ON	OFF	ON	ON	OFF	OFF
					OFF	ON

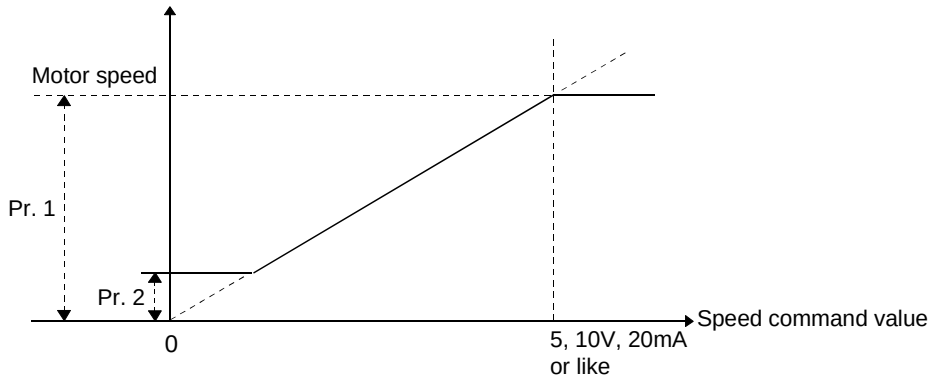
8.5 Setting of the Operation Pattern

8.5.1 Running speed region

		Initial value
Pr. 1	**"maximum speed"**	**3000**
Pr. 2	**"minimum speed"**	**0**

Pr.	Setting Range	Unit
1	0 to 3000	r/min
2	0 to 3000	r/min

You can set the upper and lower limits of the motor speed.
If the speed command entered is more than the maximum speed set in Pr. 1, the running speed is clamped at the maximum speed.
If the speed command entered is less than the minimum speed set in Pr. 2, the running speed will not fall below the minimum speed.
If the speed command is not input, turning "ON" the start signal will start operation at the minimum speed.



		Initial value
Pr. 13	**"minimum motor speed"**	**100**

Setting Range	Unit
40 to 100	r/min

The motor stops in response to any speed command less than the value set in Pr. 13. When the speed command rises to or above the preset value, the motor speed increases in accordance with the acceleration time set in Pr. 7 [Section 8.5.2].

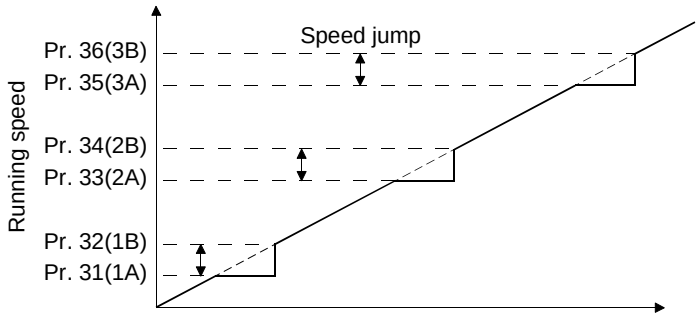
NOTICE	● Use the Pr. 13 setting at 100r/min. If that value is set to less than 100r/min, a large current may flow depending on the load, resulting in an alarm stop.

Initial value

Pr. 31 to 36 "speed command jumps 1A to 3B" 9999

Pr.		Setting Range	Unit
A point side	B point side		
31	32	0 to 3000, 9999	r/min
33	34	0 to 3000, 9999	r/min
35	36	0 to 3000, 9999	r/min

You can set up to three speed areas where continuous operation will be disabled. You can avoid continuous operation at the speed at which resonance will occur due to the natural frequency of a mechanical system. When the speed command within the setting range is input, continuous operation is performed at the preset speed of value A.
Setting "9999" in the parameter makes this function invalid.



<Setting example 1>
When you set 500 (r/min) in Pr. 31 and 700 (r/min) in Pr. 32, the running speed is 500 (r/min) if the speed command is between the range of 500 to 700 (r/min).

<Setting example 2>
When you set 700 (r/min) in Pr. 31 and 500 (r/min) in Pr. 32, the running speed is 700 (r/min) if the speed command is between the range of 500 to 700 (r/min).

MEMO	● The "speed command jump" function is designed to disable continuous operation between the preset A and B points. When the running speed command is outside A-B, the speed varies between A and B in accordance with the preset acceleration/deceleration time. ● A setting less than the Pr. 13 value will be a stop (0r/min) setting.

Initial value

Pr. 78 "reverse rotation prevention selection" 0

You can fix the direction of rotation.

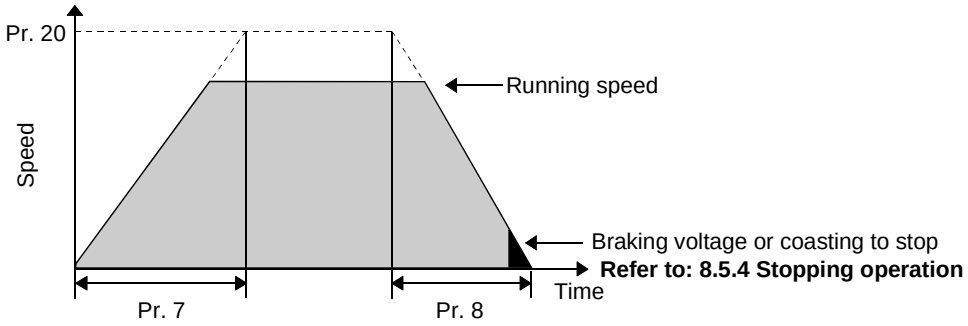
Setting	Function
0	Forward or reverse rotation operation is performed in accordance with the forward or reverse rotation command.
1	Forward rotation operation is performed in accordance with the forward rotation command. Operation is stopped in response to the reverse rotation command.
2	Reverse rotation operation is performed in accordance with the reverse rotation command. Operation is stopped in response to the forward rotation command.

8.5.2 Acceleration time and deceleration time

		Initial value
Pr. 7	**"acceleration time"**	**5**
Pr. 8	**"deceleration time"**	**5**
Pr. 20	**"acceleration/deceleration reference speed"**	**2000**
Pr. 21	**"acceleration/deceleration time unit"**	**0**

Pr.	Pr. 21	Setting Range	Unit
7, 8	0	0.0 to 3600	s
	1	0.00 to 360.0	
20	1 to 3000		r/min

In Pr. 7, set the time required to increase the speed from a start to the speed set in Pr. 20.
In Pr. 8, set the time required to decrease the speed from the speed set in Pr. 20 to a stop.
In Pr. 21, you can change the setting unit.



When the FR-DU04 operation panel is used, the minimum setting increments of the acceleration and deceleration times vary with the acceleration and deceleration time settings.

Pr.	Minimum Setting Increments			Unit
	Setting of less than 100	Setting between 100 and less than 1000	Setting of 1000 or more	
0	0.1	0.1	1	s
1	0.01		—	

MEMO

- The minimum value of acceleration/deceleration time is 0.08s. Any acceleration/deceleration time setting of less than 0.08 is handled as 0.08s.
- The upper limit of acceleration time at up to 100r/min is 5s (converted at reference speed 2000r/min). When the acceleration time setting is greater than 5s, therefore, the acceleration time required to reach the acceleration/deceleration reference speed is represented by the following expression and is shorter than the preset acceleration time:
  Required acceleration time = 0.25 + T1
  T1 = (preset speed command - 100) × Pr. 7 setting/Pr. 20 setting
- The value less than the Pr. 10 setting will voltage-brake or coast the motor to a stop. Therefore, the deceleration time required to decrease the speed from the speed set in Pr. 20 to the speed set in Pr. 10 is as follows:
  Required deceleration time = Pr. 8 setting × (Pr. 20 setting - Pr. 10 setting)/ Pr. 20 setting
- A too short acceleration/deceleration time setting can cause an abnormal stop due to overload, overcurrent or overvoltage. Make a setting which will not display overload on the operation panel.
- Rapid acceleration of less than 0.2s may make the starting torque insufficient.

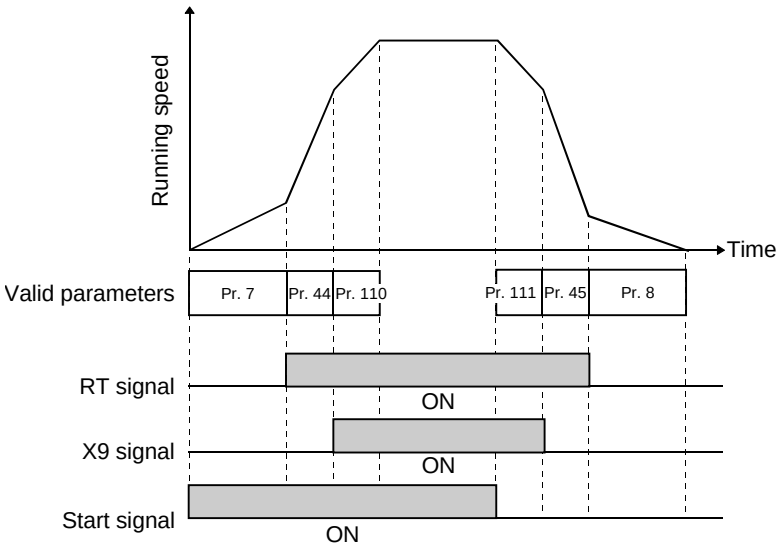
		Initial value
Pr. 44	**"second acceleration time"**	**9999**
Pr. 45	**"second deceleration time"**	**9999**
Pr. 110	**"third acceleration time"**	**9999**
Pr. 111	**"third deceleration time"**	**9999**

By turning "ON"/"OFF" the contact input signals, you can change the acceleration/deceleration time during a stop or at any point during operation. Assign the RT and X9 signals to the control circuit contact input signals.

Refer to: 8.4 Selection of the Control Circuit Contact Input Terminal Functions

As in Pr. 7 and Pr. 8, the acceleration/deceleration time is based on the value set in Pr. 20.

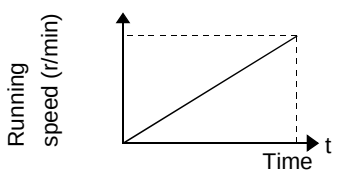
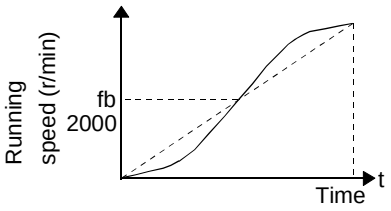
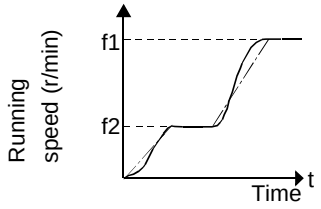
Pr.	Setting Range		Unit	Signal Used	Function
44 45	Pr. 21 = 0	0.0 to 3600	s	RT	Turning the RT signal "ON" makes the setting valid.
	Pr. 21 = 1	0.00 to 360.0			
	9999		—		Even if the RT signal is turned "ON", the setting is invalid and the acceleration/deceleration time is as set in Pr. 7/Pr. 8.
110 111	Pr. 21 = 0	0.0 to 3600	s	X9	Turning the X9 signal "ON" makes the setting valid.
	Pr. 21 = 1	0.00 to 360.0			
	9999		—		Even if the X9 signal is turned "ON", the setting is invalid and the acceleration/deceleration time is as set in Pr. 7/Pr. 8.



8.5.3 Acceleration/deceleration patterns

		Initial value
Pr. 29	**"acceleration/deceleration pattern"**	**0**

You can change the acceleration/deceleration pattern.

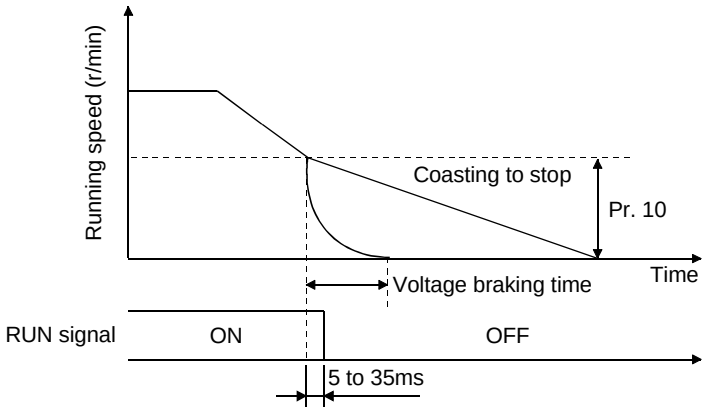
Setting	Name	Function	Time vs. Speed
0	Linear acceleration/ deceleration	In this pattern, the speed varies with the time constantly.	[Linear acceleration/deceleration] 
1	S-shaped acceleration/ deceleration A	In this pattern, the speed varies from a start to the maximum speed with the rated speed given at an inflection point (fb). In this setting, motor torque reduction in a constant-output region is taken into consideration, e.g. application to machine tool spindles.	[S-shaped acceleration/deceleration A] 
2	S-shaped acceleration/ deceleration B	This pattern always ranges from the present running speed and a newly set speed. Since an acceleration/deceleration shock is eased, this pattern has an effect on the prevention of cargo collapse as in a conveyor.	[S-shaped acceleration/deceleration B] 

MEMO	● When Pr. 29 = 1, the acceleration/deceleration time setting reference speed is not as set in Pr. 20 [Section 8.5.2] "acceleration/deceleration reference speed" but is the rated speed of the motor.

8.5.4 Stopping operation

		Initial value
Pr. 10	**"braking voltage operation speed"**	**100**
Pr. 11	**"braking voltage operation time"**	**9999**

Pr.	Setting Range	Unit	Operation
10	40 to 200	r/min	At the preset speed or less, the motor is stopped by voltage braking.
11	0.0 to 60.0	s	The voltage braking time is fixed to the preset value regardless of the time required for the motor to stop. Setting "0" coasts the motor to a stop at the Pr. 10 setting or less.
	9999	—	The motor's terminal voltage is detected to adjust the voltage braking time (0 to 3s) automatically.



The voltage braking time varies with the load inertia moment.
The guideline of the voltage braking time relative to the motor shaft-load inertia moment ratio is as indicated below.

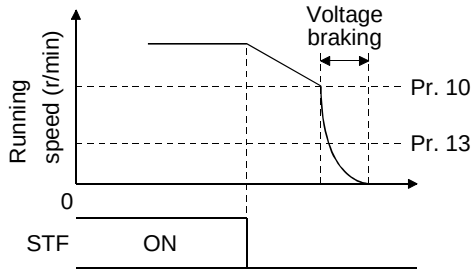
Moment ratio	5 times	38 times	77 times
Voltage braking time	50ms	250ms	600ms

Voltage braking operates as described below depending on the magnitude relationship with the Pr. 13 [Section 8.5.1] "minimum motor speed" setting.

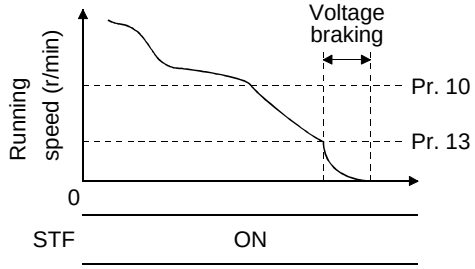
(1) If Pr. 13 setting is greater than Pr. 10 setting
- Voltage braking operates when the speed falls to less than the Pr. 13 setting.

(2) If Pr. 13 setting is less than Pr. 10 setting

1) When deceleration started at start signal OFF
- Voltage braking operates at less than the Pr. 10 setting.
- When the running speed is between the Pr. 10 and Pr. 13 settings, voltage braking operates as soon as the start signal turns OFF.



2) When deceleration started by reducing the operation command value
- Voltage braking operates at less than the Pr. 13 setting.



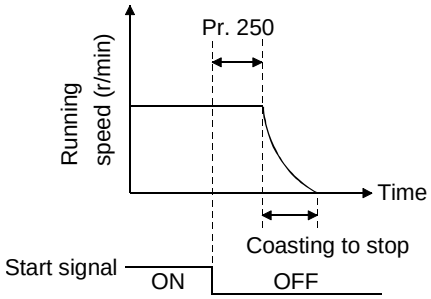
MEMO	● Voltage braking utilizes dynamic braking according to the motor's terminal voltage. Therefore, at less than low-speed rotation (approx. 20r/min) the motor terminal voltage becomes faint, the braking force does not work, the motor will coast to a stop.

NOTICE	● Use the Pr. 10 setting at 100r/min or more. If the value is set to less than 100r/min, a large current may flow depending on the load, resulting in an alarm stop.

		Initial value
Pr. 250	**"coasting-to-stop setting"**	**9999**

Set this parameter to coast the motor to a stop when the start signal is turned "OFF".

Setting Range	Unit	Operation
0.0 to 100.0	s	The motor starts coasting the preset time after the start signal has turned "OFF". If the start signal is turned "ON" within the preset time, coasting to a stop is made invalid and operation continues.
9999	—	This function is made invalid.



8.5.5 Selection of regenerative brake unit

		Initial value
Pr. 30	**"regenerative brake option selection"**	**0**
Pr. 70	**"regenerative brake duty"**	**3**

Pr.	Setting Range	Unit
30	0, 1, 2	—
70	0.0 to 15.0	%

Set Pr. 30 and Pr. 70 according to the regenerative brake unit used. At the setting of Pr. 30 = 0, the Pr. 70 "regenerative brake duty" value is fixed at 3% and Pr. 70 cannot be read.
When Pr. 30 = 1, set the value given in the following table since Pr. 70 setting is enabled.
When Pr. 30 = 2, the built-in brake circuit is disabled.

Regenerative Brake Option	Pr. 30	Pr. 70
Built-in brake resistor	0	—
BU-□□ brake unit (option)	0	—
FR-ABR-□□ high-duty brake resistor (option)	1	10
FR-HC high power factor converter (option)	2	—

⚠ CAUTION

● **Do not set the Pr. 70 value which exceeds the setting of the brake resistor used. Doing so will overheat the brake resistor.**

8.5.6 Stall prevention operation level

		Initial value
Pr. 22	**"stall prevention operation level"**	**150**

Setting Range	Unit	Remarks
0, 150	%	When 0 is set, the stall prevention function is not activated.

When the output current reaches the Pr. 22 setting, the speed is varied with the running status to suppress the torque. The setting is based on the rated motor current.
When the stall prevention function is activated, OL appears on the screen of the operation panel or FR-PU04 parameter unit. That the stall prevention function has been activated can be exported as OL signal from the terminal.

Refer to: 8.7.2 Selection of the control circuit output terminal functions

		Initial value
Pr. 156	**"stall prevention operation selection"**	**1**

You can select whether or not to perform stall prevention operation according to the operation status.

Operation Status				Setting	
Acceleration	**Constant speed**	**Deceleration**	**Region**	**When OL signal is output to continue operation**	**When E. OLT is displayed to stop operation**
○ Yes	○ Yes	○ Yes	Driving and regenerative	1	17
● No	○ Yes	○ Yes		3	19
○ Yes	● No	○ Yes		5	21
● No	● No	○ Yes		7	23
○ Yes	○ Yes	● No		9	25
● No	○ Yes	● No		11	27
○ Yes	● No	● No		13	29
● No	● No	● No		15	31
○ Yes	○ Yes	○ Yes	Driving	101	Regenerative
● No	● No	● No	Setting disabled		

Refer to: Chapter 6, 6.1.1 Protective function activated
8.7.2 Selection of the control circuit output terminal functions

MEMO	● If the stall prevention function is activated during acceleration or deceleration, the acceleration or deceleration time [Section 8.5.2] will be longer than the setting. When the travel of a machine or the like is determined by the acceleration or deceleration time, the travel will increase due to the operation of the stall prevention function. ● If the stall prevention function is activated during constant speed operation, the running speed may vary abruptly.

8.5.7 Selection of motor tone

		Initial value
Pr. 72	**"motor tone selection"**	**1**

Setting Range	Unit
1 to 4	—

Increasing the setting will decrease noise (metallic tone) from the motor, but will increase the electromagnetic noise amount generated from the drive unit.

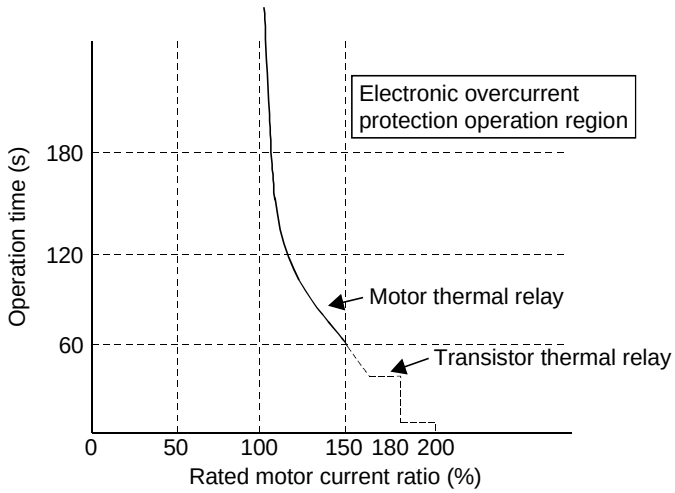
8.5.8 Other settings

		Initial value
Pr. 9	**"electronic thermal O/L relay"**	**1**

The motor thermal relay is used to protect the motor from overheat, and the transistor thermal relay is used to protect the drive unit from overload. Normally set 1.

Setting	Motor Thermal Relay Operation	Transistor Thermal Relay Operation
0	No	Yes
1	Yes	Yes

<Electronic overcurrent protection curve>



MEMO	● The electronic overcurrent protection curve is fixed independently of the motor speed.

⚠ CAUTION

● **The electronic overcurrent protection function is initialized when the drive unit is reset (power-off reset, or reset using RES terminal or key operation). Frequent resetting of the drive unit will disable motor overheat protection and may cause the motor to be burnt if it is operated under overload.**

Pr. 84 "rated motor speed" Read-only

The rated speed of the motor used with the drive unit is displayed. This parameter is for read-only and its value cannot be changed.

Initial value

Pr. 244 "cooling fan operation selection" 0

When the drive unit has a built-in cooling fan, you can select the operation of the cooling fan.

Setting	Operation
0	While the drive unit power is on, the cooling fan keeps running.
1	While the motor is operating, the cooling fan keeps running. While the motor is at a stop, the cooling fan is stopped according to the temperature of the drive unit.

MEMO	● If the cooling fan stops due to a failure, the "FN" alarm indication appears on the operation panel. **Refer to: Chapter 6, 6.1.2 Alarm function activated** ● That the cooling fan has stopped due to a failure can be exported as an alarm signal. **Refer to: 8.7.2 Selection of the control circuit output terminal functions** ● When Pr. 244 = 1, the alarm function is activated if the fan starts running during the fan "OFF" command.

Initial value

Pr. 990 "buzzer control" 1

You can make the buzzer "beep" when you press any key of the operation panel or FR-PU04 parameter unit.

Setting	Function
0	Without beep
1	With beep

8.6 Setting of Various Operation Methods

8.6.1 JOG operation

		Initial value
Pr. 15	**"JOG speed"**	**200**
Pr. 16	**"JOG acceleration/deceleration time"**	**0.5**

Pr.		Setting Range	Unit
15		100 to 3000	r/min
16	Pr. 21 = 0	0.0 to 3600	s
	Pr. 21 = 1	0.00 to 360.0	

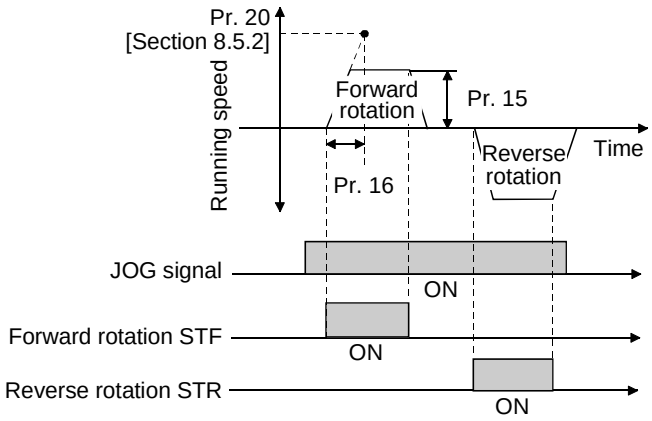
Set the speed for JOG operation in Pr. 15, and the acceleration/deceleration time in Pr. 16.

(1) External JOG operation

Use the start signal (terminal STF, STR) to perform JOG operation.

1) Set the unit in the external operation mode.

2) Turning "ON" the JOG signal allows JOG operation to be performed with the start signal.

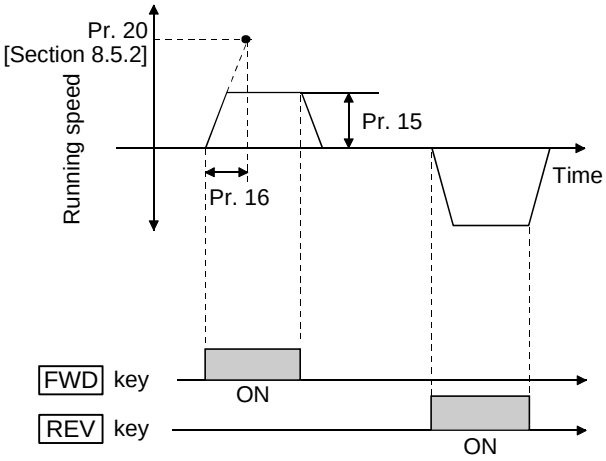


(2) PU JOG operation

Use the FWD or REV key of the operation panel to perform JOG operation.

1) Set the unit in the PU operation mode and choose the PU JOG operation mode.

2) Holding down the FWD or REV key enables JOG operation.



MEMO	● There will be an about 0.1s delay between a JOG command input and a motor start. **Refer to: Chapter 5, 5.3.5 Starting operation**

8.6.2 Communication operation from the PU connector

		Initial value
Pr. 117	**"station number"**	**0**
Pr. 118	**"communication speed"**	**192**
Pr. 119	**"stop bit length/data length"**	**1**
Pr. 120	**"parity check presence/absence"**	**2**
Pr. 121	**"number of communication retries"**	**1**
Pr. 122	**"communication check time interval"**	**0**
Pr. 123	**"waiting time setting"**	**9999**
Pr. 124	**"CR-LF presence/absence selection"**	**1**

Make settings necessary for performing RS-485 communication operation from the PU connector using a personal computer or similar equipment.
After you have made parameter settings, reset the CPU or switch power "OFF" once. Switching power on again makes the parameter values valid.

Pr.	Setting Range	Unit	Description
117	0 to 31	Station	Set the station number of the drive unit.
118	48	—	4800bps
	96	—	9600bps
	192	—	19200bps
119	0	—	Stop bit length 1 bit/data length 8 bits
	1	—	Stop bit length 2 bits/data length 8 bits
	10	—	Stop bit length 1 bit/data length 7 bits
	11	—	Stop bit length 2 bits/data length 7 bits
120	0	—	None
	1	—	Odd parity present
	2	—	Even parity present
121	0 to 10	Times	Set the number of retries to be made at occurrence of a data receive error. If errors in excess of the setting occur consecutively, E. PUE appears, resulting in an alarm stop.
	9999	—	Assigning the LF signal to the control circuit output terminal allows a communication error occurrence signal to be output. Occurrence of a communication error will not cause an alarm stop.
122	0	—	No communication. (Communication operation not performed)
	0.01 to 999.8	s	When a no-communication status time reaches the setting, E. PUE appears and an alarm stop occurs.
	9999		No-communication status time check is not made.
123	0 to 150	—	Set the waiting time from when the drive unit has received data until it gives a reply. The actual waiting time is (setting × 10 + 12)ms.
	9999	—	Set the waiting time using communication data.
124	0	—	Without CR (carriage return), LF (line feed)
	1	—	With CR (carriage return)
	2	—	With CR (carriage return)/LF (line feed)

(1) Communication specifications

Conforming standard		RS-485 Standard conformance
Number of units connected		1 : N (max. 32 units)
Communication speed		Selected between 19200, 9600 and 4800bps
Control protocol		Asynchronous
Communication method		Half-duplex
Communication data	Character system	ASCII (7 bits/8 bits) selectable
	Stop bit length	Selectable between 1 bit and 2 bits.
	Terminator	CR/LF presence/absence selectable
	Parity check	Selectable between presence (even/odd) and absence
	Sumcheck	Presence
	Waiting time setting	Selectable between presence and absence

(2) Communication operation functions

● Setting a value other than 0 in Pr. 122 enables RS-485 communication with the computer connected to the PU connector, allowing you to make operation and parameter settings.

Setting Item		Description
Operation	Start	Give a forward rotation operation, reverse rotation operation or stop command.
	Speed setting	Set the running speed.
	Monitor	You can read the motor speed, motor current, output voltage, drive unit fault, or control circuit output terminal assignment function activated.
	Reset	Used to reset the drive unit. A reset from the terminal RES is also valid. Reset operation is performed as set in Pr. 188 [Section 8.4].
Parameter write and read		You can change or read each parameter value. Parameter write is performed as set in Pr. 77 [Section 8.1].

● You can select the operation mode through communication.

Operation Mode	Description
Communication operation mode	Operation and parameter write/read are performed through communication.
External operation mode	Start and speed setting are made using the input signals from the control circuit terminals. Setting external/PU combined operation 1 in the operation mode selection (Pr. 79 [Section 8.2]) enables speed setting through communication. Though monitor and parameter read can be performed through communication, parameter write cannot be performed.

● The following operation is performed when a communication operation fault occurs.

Location of Fault Occurrence	Operation	
	Communication operation mode	External operation mode
Drive unit	Motor operation stopped	Motor operation stopped
	Communication continued	Communication continued
Communication (Computer or communication cable)	Whether motor operation is stopped or continued depends on the Pr. 75 [Section 8.2] setting.	Motor operation continued
	Communication stopped	Communication stopped

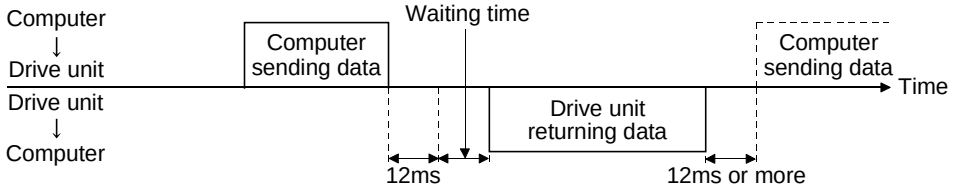
NOTICE	● Communication operation is performed in response to the communication request from the personal computer. Therefore, if communication is suspended due to a communication cable break or computer failure during operation, the drive unit cannot detect a fault and stop operation. However, operation is brought to an alarm stop (E. PUE) if the time set as the communication check time interval has elapsed. To stop operation before the time set as the communication check time interval is reached, reset the CPU using the RES terminal or switch power off. The motor will then coast to a stop.

(3) Communication data and communication protocol

The following table provides the communication data and communication protocol between the computer and drive unit.

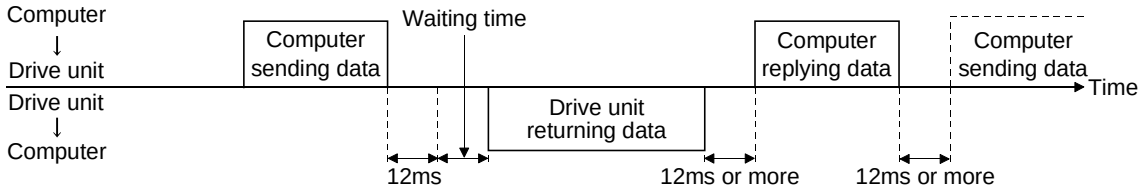
Communication Data	Description
Computer sending data	The computer gives a communication request to the drive unit in accordance with the user program
Drive unit returning data	In response to the communication request from the computer, the drive unit returns data to the computer.
Computer replying data	The computer replies to the drive unit whether it could receive the drive unit returning data properly or not.

● Communication protocol in write mode (when drive unit writes data)



MEMO	● On detection of an error at the receipt of the data sent by the computer, the drive unit returns an error code, making the sent data invalid. Data is retransmitted (resending of data by the computer) when an error occurs. Setting of Pr. 121 allows the drive unit to come to an alarm stop if consecutive errors occur in the computer sending data.

● Communication protocol in read mode (when data is read from drive unit)



MEMO	● On detection of an error at the receipt of the drive unit returning data, an error occurrence is sent using the computer replying data. In this case, the drive unit makes retry transmission (resending of drive unit returning data). Setting of Pr. 121 allows the drive unit to come to an alarm stop if consecutive errors occur in the computer replying data.

Approximately 12ms plus waiting time after the drive unit has completed receiving the data sent by the computer, the drive unit sends the drive unit returning data to the computer.
Set the waiting time in Pr. 123 to match the answerable time of the computer.

MEMO	● The waiting time may also be set using the computer sending data. In this case, set 9999 in Pr. 123.

NOTICE	● Always allow for more than 12ms to pass after sending or receiving a message before initiating another send message from the computer.

(4) Communication data structure

Mode	Communication Data		Number of Characters 1	2 3	4 5	6 7	8 9	10
Write	Computer sending data		ENQ	Station number	Instruction code	Data code	Sumcheck	CR LF
	Drive unit returning data	Without error	ACK	Station number	CR LF			
		With error	NAK	Station number	Error code	CR LF		
Read	Computer sending data		ENQ	Station number	Instruction code	Sumcheck	CR LF	
	Drive unit sending data	Without error	STX	Station number	Data code	EXT	Sumcheck	CR LF
		With error	NAX	Station number	Error code	CR LF		
	Computer replying data	Without error	ACK	Station number	CR LF			
		With error	NAK	Station number	CR LF			

MEMO

- The above format assumes that the data code has two characters. The number of characters in the data code changes with the communication data.
- When using the computer sending data to set the "waiting time", insert the "waiting time" data (one character) in the position next to the instruction code.

In this case, set 9999 in Pr. 123.

(Example)

ENQ	Station number	Instruction code	Waiting time	Data code	Sumcheck	CR LF

- The CR (carriage return) and LF (line feed) codes at the format end are automatically set by the computer when data is sent from the computer to the drive unit.

  In this case, the sending data from the drive unit must also be set to match the computer data.

  Select whether the CR and LF are used or not by setting the Pr. 124 value.
- Expression for calculating the communication data sending time

  Data send time (s) = total number of bits in one character × total number of characters ÷ communication speed (bps)

  The total number of bits in one character is equal to the total number of following bits.

  Start bit: 1 bit
  Data: 7 or 8 bits (selected using Pr. 119)
  Stop bit: 1 or 2 bits (selected using Pr. 119)
  Parity check: 0 or 1 bit (selected using Pr. 120)

(5) Explanation of communication data structure

1) Control codes

The following table lists the ASCII codes and their definitions of the control code names which are set at the beginning, end and like of the format.

Signal Name	ASCII Code	Description
STX	H02	Start of Text (Start of data)
ETX	H03	End of Text (End of data)
ENQ	H05	Enquiry (Communication request)
ACK	H06	Acknowledge (No data error detected)
LF	H0A	Line Feed
CR	H0D	Carriage Return
NAK	H15	Negative Acknowledge (Data error detected)

2) Station number

Specify the station number of the drive unit used for communication with the computer. Specify the drive unit station number within the range H00 to H1F (stations 0 to 31) in hexadecimal.

The communication data is converted into ASCII automatically.

Example: H00 (binary) → H3030 (ASCII)

3) Instruction codes and data codes

Set the instruction code and data code which correspond to the operation mode, operation or parameter write or read. The communication data is converted into ASCII automatically.

i) Setting the operation mode

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Operation mode	Write	HFB	H0000: Spare H0001: Eternal operation mode H0002: Communication operation mode	4
	Read	H7B	H0000: Spare H0001: Eternal operation mode H0002: Communication operation mode	4

ii) Setting the operation items

Setting Item		Mode	Instruction Code	Data Codes and Definitions			Character count
Start		Write	HFA	H00: Stop H02: Forward rotation H04: Reverse rotation b7 b0 0 0 0 0 0 0 1 0 (For forward rotation)			2
Speed setting (RAM)		Write	HED	H0000 to H0BB8: 1r/min increments (hexadecimal) To change the running speed consecutively, write to the drive unit RAM.			4
		Read	H6D				
Speed setting (E^2PROM)		Write	HEE	H0000 to H0BB8: Unit 1r/min (hexadecimal)			4
		Read	H6E				
Monitor	Speed	Read	H6F	H0000 to H0BB8: 0 to 3000r/min			4
	Motor current	Read	H70	H0000 to HC350: 0 to 500.00A			4
	Output voltage	Read	H71	H0000 to H0FA0: 0 to 400.0V			4
	Selective monitor	Read	H72	H0000 to HFFFF: Monitor data selected using the selective monitor No. (instruction code HF3)			4
	Selective monitor No.	Write	HF3	H01: Output frequency (increments: 0.01Hz) H02: Output current (increments: 0.01A) H03: Output voltage (increments: 0.1V) H05: Speed setting (increments: 1r/min) H06: Running speed (increments: 1r/min) H09: Regenerative brake duty (increments: 0.1%) H0A: Electronic overcurrent protection load factor (increments: 0.1%) H0B: Output current peak value (increments: 0.01A) H0C: Converter output voltage peak value (increments: 0.1V)			2
		Read	H73				
	Alarm code	Read	H74	H** ** Latest alarm Previous alarm	H00: No alarm H10: 0C1 H11: 0C2 H12: 0C3 H20: 0V1 H21: 0V2 H22: 0V3 H30: THT H31: THM H40: FIN H50: IPF H51: UVT H60: OLT H70: BE H80: GF H81: LF H90: OHT	HA0: OPT HA1: — HA2: — HA3: — HB0: PE HB1: PUE HB2: RET HC1: CTE HC2: P24 HD5: — HD6: — HD7: — HD8: — HD9: — HDA: — HDB: —	4
			H75	H** ** Alarm two times prior to Alarm three times prior to			4
			H76	H** ** Alarm four times prior to Alarm five times prior to			4
			H77	H** ** Alarm six times prior to Alarm seven times prior to			4

Setting Item		Mode	Instruction Code	Data Codes and Definitions	Character count
Monitor	Drive unit status	Read	H7A	H01: Function assigned to RUN terminal is activated H02: During forward rotation (STF terminal signal ON) H04: During reverse rotation (STR terminal signal ON) H08: Function assigned to SU terminal is activated H10: Function assigned to OL terminal is activated H20: Function assigned to IPF terminal is activated H40: Function assigned to FU terminal is activated H80: Function assigned to ABC terminal is activated	2
Reset		Write	HFD	H9696: The drive unit is reset. In this case, the drive unit returning data is not returned. After a reset, wait for more than 100ms and send the computer sending data.	4
Alarm code batch-clear		Write	HF4	H9696: Eight alarms stored as a history are all cleared.	4

MEMO	● Once written, the setting of the HF3 instruction code is held, but is cleared to "0" when the drive unit is reset or all clear is performed.

iii) Parameter write and read

Parameter write and read require the setting of the extension codes given in Appendix 1 Parameter List (Numerical Order). After setting the extension code, set the instruction code given in Appendix 1 Parameter List (Numerical Order) and perform write or read.

This function is performed as set in Pr. 77.

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Extension code setting	Write	HFF	H00: Parameter of extension code 0 can be accessed for read/write. H01: Parameter of extension code 1 can be accessed for read/write. H02: Parameter of extension code 2 can be accessed for read/write. H03: Spare. H09: Parameter of extension code 9 can be accessed for read/write.	2
	Read	H7F		
Parameter	Write	Refer to Appendix 1 Parameter List.	H0000 to HFFFF: Parameter settings (hexadecimal)	4
	Read			

MEMO	● Once written, the setting of the HFF instruction code is held, but is cleared to "0" when the drive unit is reset or all clear is performed.

When converting a value having a decimal place, e.g. parameter setting range, into a data code, make conversion in the setting range whose decimal place has been carried. Use HFFFF with the value 9999 which means no function.
(Example)

Parameter	Setting Range (Parameter list)	Setting Range (Communication)	Data Code
Pr. 7	0.0 to 3600	0 to 36000	H0000 to H8CA0
Pr. 24	0 to 3000 9999	0 to 3000 9999	H0000 to H0BB8 HFFFF
Pr. 44	0.0 to 3600 9999	0 to 36000 9999	H0000 to H8CA0 HFFFF
Pr. 122	0 0.1 to 999.8 9999	0 1 to 9998 9999	H0000 H0001 to H270E HFFFF
Pr. 124	0 1 2	0 1 2	H0001 H0002 H0003

Set the bias and gains in Pr. 902 to 905.

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Bias/gain	Write	HEC	H00: Bias/gain H01: Any analog A/D value H02: Analog A/D value of terminal	2
	Read	H6C		

MEMO	● Once written, the setting of the HEC instruction code is held, but is cleared to "0" when the drive unit is reset or all clear is performed.

Clear the parameters.

Setting Item	Mode	Instruction Code	Data Codes and Definitions	Character count
Parameter clear	Write	HFC	H5A5A: The parameter settings other than the following are initialized to the factory settings. • Communication parameters (Pr. 117 to 124) • Calibration parameter (Pr. 900 [Section 8.7.5]) • Control parameters (Refer to: 8.8 Control Parameters) • Pr. 75, Pr. 188 Also use the data code H9696 to initialize the communication parameters.	4
All clear	Write	HFC	H55AA: The parameter settings other than the following are initialized to the factory settings. • Communication parameters (Pr. 117 to 124) • Pr. 75, Pr. 188 Also use the data code H9966 to initialize the communication parameters.	4
User clear	Write	HFC	H9696: The parameter settings other than the following are initialized to the user settings (Pr. 199). • Calibration parameter (Pr. 900 to Pr. 905) • Control parameters (Refer to: 8.8 Control Parameters) • Pr. 75, Pr. 188	4

4) Sumcheck

As a sumcheck value, set the lower 1 byte (8 bits) of the sum derived from ASCII data (station number, instruction code, waiting time, data code) except the control code. The communication data is converted into ASCII automatically.

Data →	ENQ	Station Number	Instruction Code	Waiting Time	Data Code	Sumcheck
Binary code →	—	0 1	E 1	1	0 7 A D	F 4
ASCII code →	(H05)	H30 H31	H45 H31	H31	H30 H37 H41 H44	(H46 H34)

Sumcheck value calculation: H30+31+45+31+31+30+37+41+44=H1F4

5) Error codes

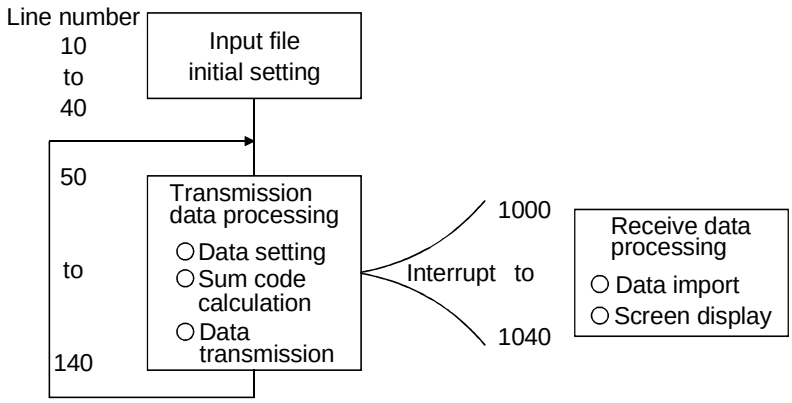
When the data received by the drive unit is in error, the error code is returned to the computer. The definitions of the error codes are as follows.

Error Code	Error Item	Error Definition	Drive Unit Operation
H0	Computer NAK error	The number of errors consecutively detected in communication request data from the computer is greater than the permissible number of retries.	If errors occur consecutively more than the permissible number of communication retries (Pr. 121 setting), the drive unit displays E. PUE and comes to an alarm stop.
H1	Parity error	The parity check result does not match the specified parity.	
H2	Sumcheck error	The sumcheck value in the computer does not match that of the data received by the drive unit.	
H3	Protocol error	Data received by the drive unit is in the wrong protocol, data receive is not completed within the given time, or CR and LF are not as set in the parameter.	
H4	Framing error	The stop bit length differs from the initial setting.	
H5	Overrun	New data has been sent by the computer before the drive unit completes receiving the preceding data.	
H7	Character error	The character received is invalid (other than 0 to 9, A to F, control code).	The receive data is made invalid and the drive unit continues operation.
HA	Mode error	Parameter write was attempted in other than the computer link operation mode or during drive unit operation, for example.	
HB	Instruction code error	The specified command does not exist.	
HC	Data range error	Invalid data has been specified for parameter write, running speed write, etc.	

(6) Program example (Switching the operation mode to communication operation)

```
                                          Initial setting of input file
 10 OPEN "COM1 : 9600,E,8,2,HD" AS #1   : Communication file opening
 20 COMST1,1,1:COMST1,2,1               : Circuit control signal (RS (ON in data-receivable
                                          status), ER (unit ready signal)) ON/OFF setting
 30 ON COM(1)GOSUB＊REC                 : Interrupt definition at data receive
 40 COM(1)ON                            : Interrupt enable
 50 D$= "01FB10002"                     Transmission data setting
 60 S=0
 70 FOR I=1 TO LEN(D$)
 80 A$=MID$(D$,I,1)
 90 A=ASC(A$)                           Sum code calculation
100 S=S+A
110 NEXTI
120 D$=CHR$(&H5)+D$+RIGHT$(HEX$(S),2) : Addition of control and sum codes
130 PRINT#1,D$                          Data transmission
140 GOTO 50
1000 ＊REC                              Interrupt data receive
1010 IF LOC(1)=0 THEN RETURN            : Interrupt occurrence at data receive
1020 PRINT "RECEIVE DATA"
1030 PRINT INPUT$(LOC(1),#1)
1040 RETURN
```

General flowchart



NOTICE	● The drive unit does not accept data from the computer if it is in error. Hence, always insert a data error retry program in the user program. ● Since the communication of any data, e.g. run command, monitor, is started from the computer, the drive unit will not return data without the computer's command. For monitoring, therefore, design the program to cause the computer to provide a data read request as required.

8.6.3 PID control operation

		Initial value
Pr. 128	**"PID action selection"**	**0**
Pr. 129	**"PID proportional band"**	**100**
Pr. 130	**"PID integral time"**	**1**
Pr. 131	**"upper limit"**	**9999**
Pr. 132	**"lower limit"**	**9999**
Pr. 133	**"PID action set point for PU operation"**	**0**
Pr. 134	**"PID differential time"**	**9999**

This function feeds back a voltage, air volume, pressure or like as a process value to control the motor speed so that the difference between the set point and process value, i.e. deviation value, is zeroed.

Pr.	Setting Range	Unit	Description	
128	0	—	No PID action	
	10	—	When deviation signal is input	PID reverse action (heating, pressure, etc.)
	11	—		PID forward action (cooling, etc.)
	20	—	When set point and process value are input	PID reverse action (heating, pressure, etc.)
	21	—		PID forward action (cooling, etc.)
129	0.1 to 1000	%	As the setting is smaller, the manipulated variable varies greatly with a slight change of the process value. Hence, the response sensitivity improves but stability deteriorates, e.g. hunting occurs.	
	9999	—	No proportional control	
130	0.1 to 3600	s	As the setting is smaller, the set point is reached faster but stability deteriorates, e.g. hunting occurs.	
	9999	—	No integral control	
131	0.0 to 100.0	%	Set the upper limit of the process value. If the process value exceeds the setting, the FUP signal assigned to the control circuit output terminal is output.	
	9999	—	No upper limit setting	
132	0.0 to 100.0	%	Set the lower limit of the process value. If the process value falls below the setting, the FDN signal assigned to the control circuit output terminal is output.	
	9999	—	No lower limit setting	
133	0.00 to 100.0	%	Only valid for the PU command in the PU operation or PU/external combined operation mode. Pr. 902 [Section 8.3.1] corresponds to 0% and Pr. 903 [Section 8.3.1] to 100%.	
134	0.01 to 10.00	s	As the setting is larger, greater response is made to a deviation signal variation.	
	9999	—	No differential control	

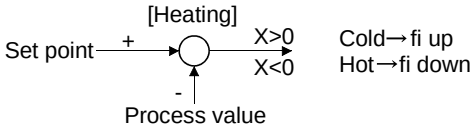
(1) PID operation setting

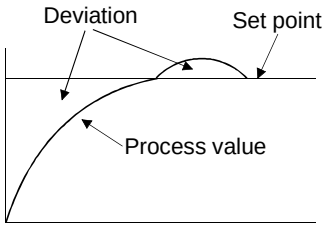
Using Pr. 128, select the PID action and speed command input method.

● Reverse action and forward action

1) Reverse action

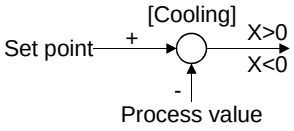
Increases the manipulated variable if deviation X (set point - process value) is positive, and decreases the manipulated variable if deviation is negative.

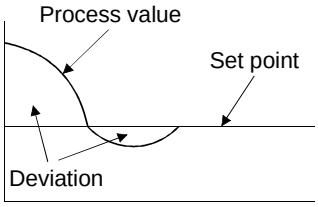




2) Forward action

Increases the manipulated variable if deviation X (set point - process value) is negative, and decreases the manipulated variable if deviation is positive.



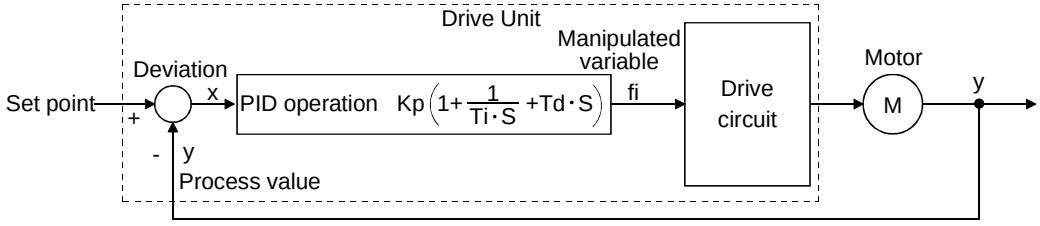


Relationships between deviation and manipulated variable

	Deviation	
	Positive	**Negative**
Reverse action	↗	↘
Forward action	↘	↗

MEMO

● Basic PID control configuration



Kp: Proportional constant Ti: Integral time S: Operator Td: Differential time

● Speed command input method

1) When the set point and process value are input to the drive unit

Pr. 128 Setting	Terminal Used	Function
20 or 21	Terminal 2	Enter the set point.
	Terminal 4	Enter the process value.
	Terminal 1	Not used.

MEMO	● The signal input to the terminal 1 is added to the set point of the terminal 2.

2) When the deviation signal (difference between set point and process value) is input to the drive unit

Pr. 128 Setting	Terminal Used	Function
10 or 11	Terminal 2	Not used.
	Terminal 4	Not used.
	Terminal 1	Enter the deviation signal.

(2) Calibrate the set point and process value as required.

● Calibrating the set point

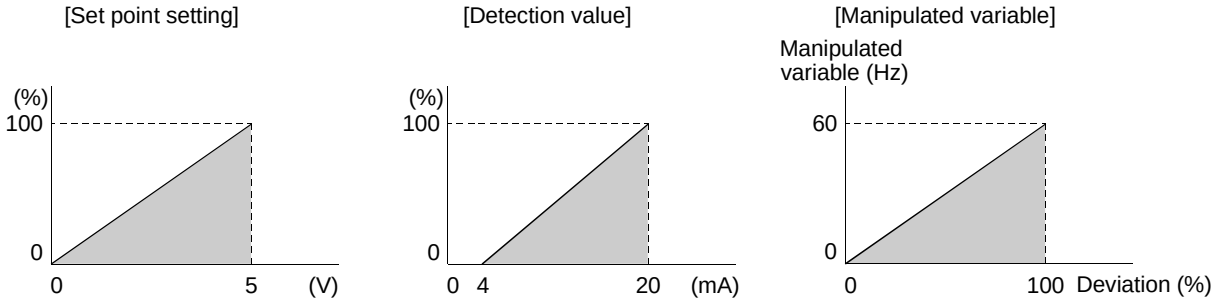
1) Apply the set point setting 0% input (e.g. 0V) to the terminal 2.
2) Make calibration using Pr. 902 [Section 8.3.1]. At this time, enter the speed which the drive unit should output at the deviation of 0% (e.g. 0Hz).
3) Apply the set point setting 100% input (e.g. 5V) to the terminal 2.
4) Make calibration using Pr. 903 [Section 8.3.1]. At this time, enter the speed which the drive unit should output at the deviation of 100% (e.g. 60Hz).

● Calibrating the detector output

1) Apply the detector setting 0% output (e.g. 4mA) to the terminal 4.
2) Make calibration using Pr. 904 [Section 8.3.1].
3) Apply the detector setting 100% output (e.g. 20mA) to the terminal 4.
4) Make calibration using Pr. 905 [Section 8.3.1].

MEMO	● In Pr. 904 and Pr. 905, set the same speeds which were respectively set in Pr. 902 and Pr. 903.

The results of calibration are as shown below.



MEMO	● For the set point, process value and deviation signal, set their % equivalents. 1) When the selected feature of the set point is 0V to +5V, 0V corresponds to 0% and +5V to 100%. When it is 0V to +10V, 0V corresponds to 0% and +10V to 100%. 2) When the process value is 4mA to 20mA, 4mA corresponds to 0% and 20mA to 100%. 3) When the deviation signal is -5V to +5V, -5V corresponds to -100%, 0V to 0%, and +5V to 100%. When it is -10V to +10V, -10V corresponds to -100%, 0V to 0%, and +10V to 100%. ● Set the Pr. 133 value when entering the set point from the operation panel.

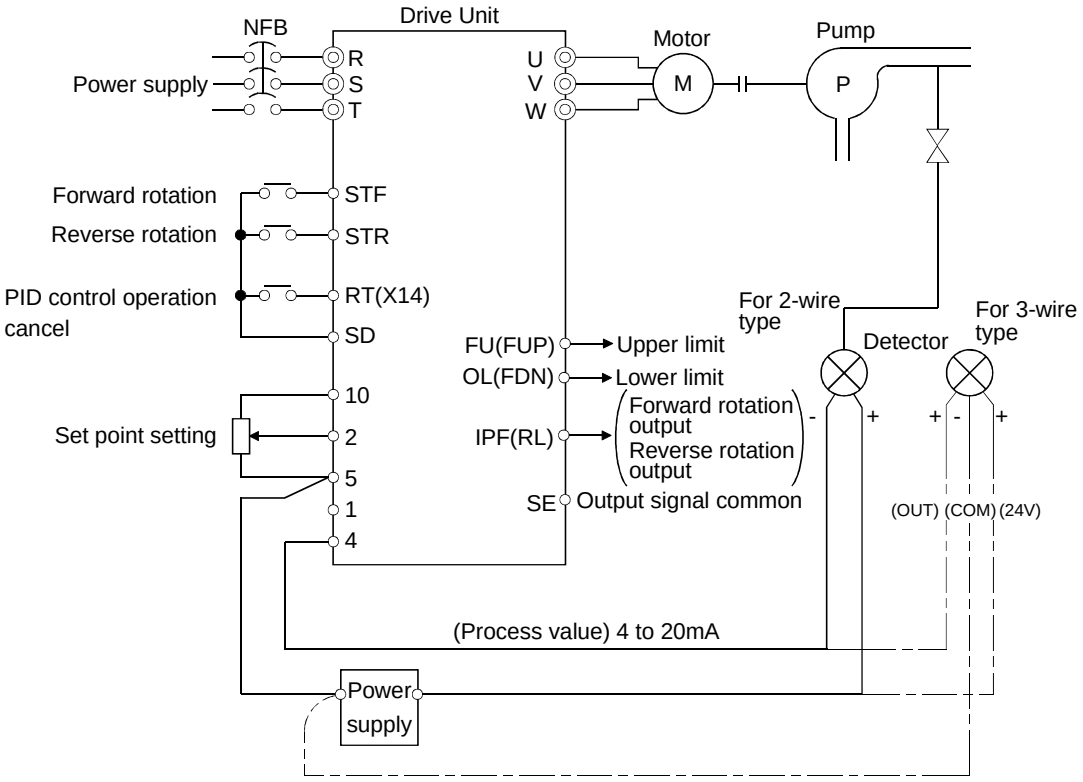
(3) Assign the used input and output signals.

Refer to: 8.4 Selection for the Control Circuit Contact Input Terminal Functions
8.7.2 Selection for the control circuit output terminal functions

Signal Name		Function
Input	X14	Enter this signal to cancel PID control operation. Input of the X14 signal stops PID action and starts normal operation.
Output	FUP	Turns "ON" when the process value input to the terminal 4 exceeds the Pr. 131 setting.
	FDN	Turns "ON" when the process value input to the terminal 4 exceeds the Pr. 132 setting.
	RL	Turns "ON" when the output display of the operation panel is forward rotation (FWD). Turns "OFF" when the display is reverse rotation (REV) or stop (STOP).

MEMO	● Entry of multi-speed (RH, RM, RL signal) or JOG operation (JOG signal) stops PID control and starts multi-speed operation [Section 8.3.2] or JOG operation [Section 8.6.1]. ● When you selected the setting of Pr. 79 = 6 (switch-over mode [Section 8.2]), you cannot perform PID operation.

(4) Wiring example (when set point and process value are entered to perform PID operation)

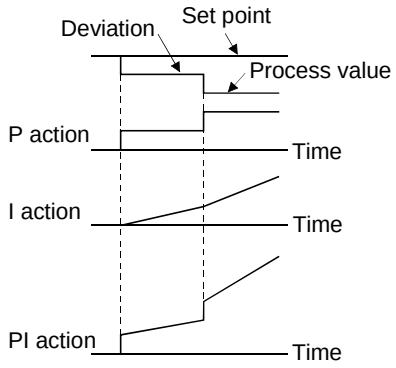


MEMO	● Makesure the detector power supply matches the specifications of the detector used. ● When the Pr. 128 value is set to choose PID action, the terminal 4 is made valid automatically. You need not turn "ON" the contact input terminal where the AU signal has been assigned.

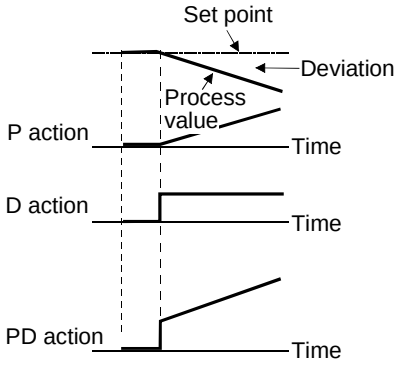
(5) Adjustment

In Pr. 129, 130 and 134, set the proportional band (P), integral time (I) and differential time (D). First set the proportional band a little larger, the integral time a little longer, and the differential time a little shorter. While looking at the system operation, reduce the proportional band, decrease the integral time, and increase the differential time.

1) PI control
   A combination of proportional control action (P) and integral control action (I) for providing a manipulated variable in response to deviation and changes with time.
   [Operation example for stepped changes of process value]
   Note: PI action is the sum of P and I actions.



2) PD control
   A combination of proportional control action (P) and differential control action (D) for providing a manipulated variable in response to deviation speed to improve the transient characteristic.
   [Operation example for proportional changes of process value]
   Note: PD action is the sum of P and D actions.



3) PID control
   The PI action and PD action are combined to utilize the advantages of both actions for control.
   Note: The PID action is the sum of P and I and D actions.

(6) Setting example

A detector which outputs the process values of 4mA at 0°C and 20mA at 50°C is used to adjust the temperature to 25°C under PID control.

Procedure		Description
Determine the set point.	Determine the set point of the item to be adjusted.	Set Pr. 128.
Convert the set point into %.	Calculate the ratio of the set point to the detector output.	When the detector used has the specifications that 0°C is equivalent to 4mA and 50°C to 20mA, the set point 25°C is 50% because 4mA is equivalent to 0% and 20mA to 100%.
Calibrate the signals.	Calibrate the set point input and detector output as required.	Make calibration using Pr. 902 to 905 [Section 8.3.1].
Set the set point.	Enter a voltage into terminal 2 according to the set point (%).	When the selected feature of the terminal 2 is 0 to 5V, 0V corresponds to 0% and 5V to 100%. Therefore, enter 2.5V which corresponds to 50%. When entering the set point from the operation panel, set "50" in Pr. 133.
Operation	Turn "ON" the start signal and check that the process value is stable.	Set the proportional band, Pr. 129, slightly larger, the integral time, Pr. 130, slightly longer, and the differential time, Pr. 134, slightly shorter, and start operation.
Adjustment	Stabilize the operating status (detector output).	● When stable Reduce the proportional band, decrease the integral time, and increase the differential time to increase the response performance. ● When instable Increase the proportional band, increase the integral time, and decrease the differential time.

8.6.4 Alarm retry operation

		Initial value
Pr. 65	**"retry item selection"**	**3**

A retry is a function to automatically reset an alarm and restart operation if an alarm is detected and operation stopped. The following table gives the alarms which enable a retry. By changing the set value, you can select the alarm group which is reset for a retry. ○ indicates the alarms to be reset for a retry.

Alarm Displayed on Operation Panel (Actual Characters)	Setting					
	0	1	2	3	4	5
 (E. 0C1)	○	○		○	○	○
 (E. 0C2)	○	○		○	○	
 (E. 0C3)	○	○		○	○	○
 (E. 0V1 to E. 0V3)	○		○	○	○	
 (E. THM)	○					
 (E. THT)	○					
 (E. IPF)	○				○	
 (E. UVT)	○				○	
 (E. GF)	○				○	
 (E. OHT)	○					
 (E. OLT)	○				○	

Refer to: Chapter 6, 6.1.1 Protective function activated

		Initial value
Pr. 67	**"retry count selection"**	**0**

Select the number of retries to be executed.

Setting Range	Retry Count	Alarm Signal Output during Retry Period
0	No retry function	—
1 to 10	1 to 10 times	Not output
101 to 110	1 to 10 times	Output

If operation cannot be resumed within the preset number of retries, "E. RET" appears on the operation panel, the alarm signal is output, and operation is stopped.

Refer to: Chapter 6, 6.1.1 Protective function activated

Initial value

Pr. 68 "retry time selection" 1

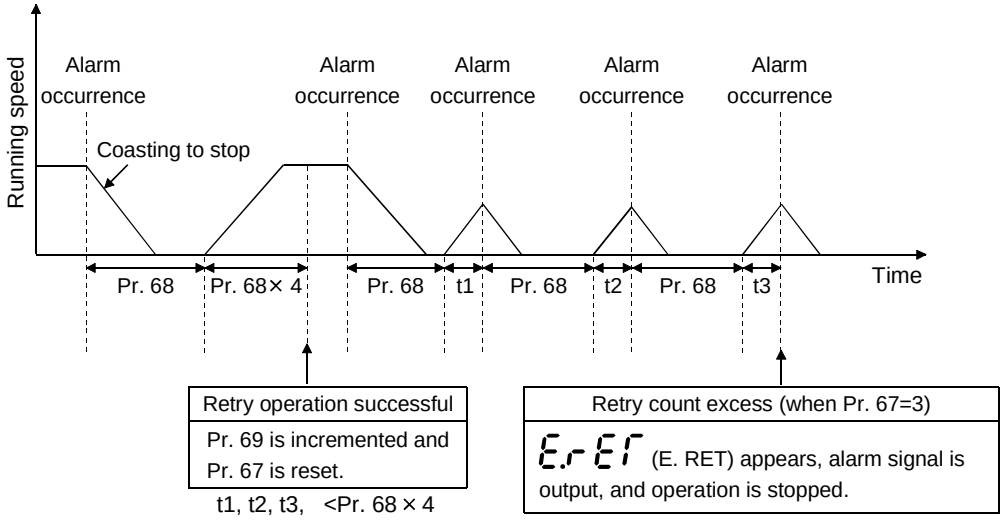
Setting Range	Unit	Function
0.0 to 10.0	s	Select the waiting time from an alarm occurrence stop to a retry start.

When the motor is restarted by a retry during coasting, the overcurrent alarm may be activated. Set Pr. 68 so that a retry is made after the motor has stopped.

Initial value

Pr. 69 "retry count display" 0

When a period five times longer than the value set in Pr. 68 has elapsed after operation is restarted by a retry, Pr. 69 shows the cumulative number of successful retries. Write "0" to clear the cumulative count.



Refer to: Chapter 6, 6.1.1 Protective function activated

MEMO	● If alarms occur consecutively within a period five times longer than the time set in Pr. 68, the operation panel may display an alarm which is different from the latest alarm code. When a retry is made, only the alarm code which occurred the first time is stored. ● When an alarm is reset at a retry made by the retry function, the accumulated data of the electronic overcurrent protection and others are not cleared.

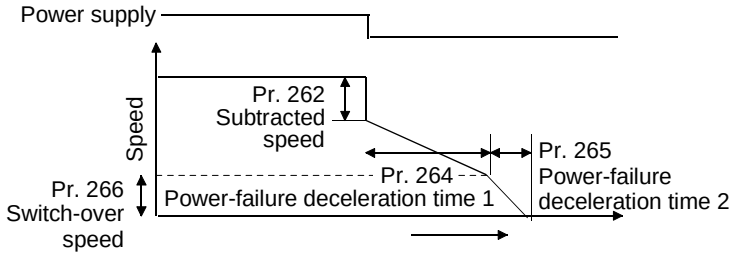
⚠ CAUTION

● **When you have set the retry function, stay away from the motor and machine. The motor will start suddenly while it is at an alarm occurrence stop.**

8.6.5 Power failure deceleration-to-stop operation

		Initial value
Pr. 261	**"power failure stop selection"**	**0**
Pr. 262	**"subtracted speed at deceleration start"**	**0**
Pr. 263	**"subtraction starting speed"**	**2000**
Pr. 264	**"power-failure deceleration time 1"**	**5**
Pr. 265	**"power-failure deceleration time 2"**	**9999**
Pr. 266	**"power-failure deceleration time switch-over speed"**	**2000**

If input power is switched "OFF" due to a power failure, regenerative energy from the motor can be utilized to decelerate the motor to a stop.
Remove the jumpers across the main circuit terminals R-R1 and S-S1, and connect R1-P/+ and S1-N/-.



Pr.		Setting Range	Unit	Operation
261		0	—	Switching "OFF" input power coasts the motor to a stop.
		1	—	Switching "OFF" input power decelerates the motor to a stop
262		0 to 600	r/min	Normally, operation can be performed with the factory setting unchanged. Adjust the speed to meet the load specifications (inertia moment, torque magnitude).
263		0 to 3000	r/min	When the motor speed at power "OFF" is greater than the value set in Pr. 263, deceleration starts at the value found by subtracting the Pr. 262 setting from the motor speed. When the motor speed is less than the Pr. 263 setting, the motor is decelerated to a stop, starting at the motor speed. When the Pr. 263 setting and motor speed are close, the Pr. 262 function may not be activated.
		9999	—	Deceleration starts at the value found by subtracting the Pr. 262 setting from the motor speed at power "OFF".
264	Pr. 21 = 0	0.0 to 3600	s	Set a deceleration slope down to the Pr. 266 setting. Set the slope in terms of the deceleration time, Pr. 264, from the speed set in Pr. 20 [Section 8.5.2] to a stop. The setting range can be changed using Pr. 21 [Section 8.5.2].
	Pr. 21 = 1	0.00 to 360		
265	Pr. 21 = 0	0.0 to 3600	s	Set a deceleration slope down to the Pr. 266 setting. Set the slope in terms of the deceleration time, Pr. 264, from the speed set in Pr. 20 [Section 8.5.2] to a stop. The setting range can be changed using Pr. 21 [Section 8.5.2].
	Pr. 21 = 1	0.00 to 360		
		9999	—	The deceleration slope from the Pr. 266 setting to a stop is the value set in Pr. 264.
266		0 to 3000	r/min	Set the speed at which the deceleration slope is changed.

MEMO	● Depending on the load, the power-failure detection function may not be activated properly, causing the motor to coast to a stop. ● If the motor speed at power "OFF" is less than the Pr. 262 setting, the motor stops immediately. ● If power is switched on during power-failure deceleration operation, deceleration-to-stop operation is continued. To restart, turn "OFF" the start signal once, then turn it "ON" again. ● When the FR-HC high power factor converter is used, this function is made invalid.

8.7 Monitoring of Operation Status

8.7.1 Selection of operation panel display data

		Initial value
Pr. 37	**"speed unit switch-over 1"**	**0**

Change the display unit of the operation panel or FR-PU04 parameter unit (option).

Setting Range	Function
0	The motor speed is displayed. The unit is r/min.
1 to 9998	By setting a value corresponding to the rated speed, a machine operation amount equivalent can be displayed. At the setting of "10", 10 appears when the motor reaches the rated speed and "3" appears when the motor reaches 1/3 of the rated speed.

MEMO	● Since the operation panel display has 4 digits, "- - - -" appears when the monitor value is "10000" or greater. To display a value of "10000" or greater, use the optional FR-PU04 parameter unit. ● Changing the speed unit switch-over setting also changes the units of the other speed-related parameter settings.

		Initial value
Pr. 144	**"speed unit switch-over 2"**	**0**

Set this parameter to show the display unit of the operation panel or FR-PU04 parameter unit (option) as an output frequency.

Setting Range	Function
0	The Pr. 37 setting is enabled.
1	The Pr. 37 setting is disabled and the output frequency is displayed. The unit is Hz.

Initial value

Pr. 52 "main display screen data selection" 0

You can select the display data of the main display screen of the operation panel or FR-PU04 parameter unit (option).

Setting	Display Data	Unit	Display Screen
0	Motor speed	r/min	These data can be displayed in sequence by pressing the SET key of the operation panel or the SHIFT key of the parameter unit (FR-PU04).
	Motor current	A	
	Output voltage	V	
	Alarm indication	—	
100	Motor speed (during operation) Preset speed (during stop)	r/min	
	Motor current	A	
	Output voltage	V	
	Alarm indication	—	
5	Preset speed	r/min	These data are displayed on the voltage monitor screen. After power-on, press the SET key of the operation panel or the SHIFT key of the parameter unit (FR-PU04) twice to display the voltage monitor screen. **Refer to: Chapter 4, 4.3 Operation Procedures**
6	Motor speed	r/min	
8	Converter output voltage	V	
9	Regenerative brake duty	%	
10	Electronic overcurrent protection load factor	%	
11	Motor current peak value	A	
12	Converter output voltage peak value	V	
20	Cumulative energization time	h	
23	Actual operation time	h	

MEMO

- The actual operation time available by setting "23" is the cumulative value of motor running time and does not include the motor stop time.
  The actual operation time is incremented every hour. If the drive unit is powered off before incrementing, the operation time of less than one hour during that period is not stored.
- The cumulative energization time and actual operation time available by setting "20" and "23" are up to 65535h. After that, the values return to 0 and incremented again from 0. A value more than 9999h displayed on the operation panel is given as "- - - -". You can use the FR-PU04 to confirm the value more than 9999h.
- When the operation panel is used, the display unit is Hz, V or A only.
- Refer to the FR-PU04 instruction manual when using the FR-PU04.

Initial value

Pr. 171 "actual operation hour meter clear" 0

You can clear the actual operation time read by setting "23" in Pr. 52.
Write "0" in Pr. 171. (The parameter is factory set to "0")

MEMO	● You cannot clear the cumulative energization time read by setting 20 in Pr. 52.

Initial value

Pr. 53 "level display data selection" 1

This parameter is designed for use with the FR-PU04 parameter unit (option) only. Select the data to be displayed on the level meter of the FR-PU04.

Setting	Display Data	Unit	Full-Scale
0	No indication	—	—
1	Motor speed	r/min	Value set in Pr. 55 [Section 8.7.5]
2	Motor current	A	Value set in Pr. 56 [Section 8.7.5]
3	Output voltage	V	400V
5	Preset speed	r/min	Value set in Pr. 55 [Section 8.7.5]
8	Converter output voltage	V	400V
9	Regenerative brake duty	%	Value set in Pr. 70 [Section 8.7.5]
10	Electronic overcurrent protection load factor	%	Thermal relay operation level
11	Motor current peak value	A	Value set in Pr. 56 [Section 8.7.5]
12	Converter output voltage peak value	V	400V

8.7.2 Selection of the control circuit output terminal functions

		Initial value
Pr. 190	**"RUN terminal function selection"**	**0**
Pr. 191	**"SU terminal function selection"**	**1**
Pr. 192	**"IPF terminal function selection"**	**2**
Pr. 193	**"OL terminal function selection"**	**3**
Pr. 194	**"FU terminal function selection"**	**4**
Pr. 195	**"A, B, C terminal function selection"**	**99**

You can select/change the functions of the control circuit output terminals. At the initial values, the terminal names and signal names match.
<Setting example>
When Pr. 190 = 99, the RUN terminal provides the function of the ABC terminal. In this case, if the Pr. 195 setting is "99", the RUN terminal has the same function as that of the ABC terminal, and the same signal is available from the two terminals.

Setting		**Signal Name**	**Operation at Positive Logic Setting ("ON" and "OFF" are reversed for negative logic setting)**
Positive logic	**Negative logic**		
0	100	RUN	"ON" during motor operation, "OFF" during voltage braking operation or stop.
1	101	SU	Turns "ON" when the preset speed is reached. **Refer to: 8.7.3 Detection of running speed**
2	102	IPF	Turns "ON" on detection of an instantaneous power failure or undervoltage.
3	103	OL	Turns "ON" when the stall prevention function is activated. **Refer to: 8.5.6 Stall prevention operation level**
4	104	FU	Turns "ON" at the preset speed or more. **Refer to: 8.7.3 Detection of running speed**
5	105	FU2	
6	106	FU3	
7	107	RBP	"ON" when the regenerative brake option duty is 85% or higher. **Refer to: Pr. 70 [Section 8.5.5]**
8	108	THP	"ON" when the electronic overcurrent protection operation level is 85% or higher. **Refer to: Section 8.5.8 Other settings**
10	110	PU	Turns "ON" when the PU operation mode is selected. **Refer to: Pr. 79 [Section 8.2]**
11	111	RY	"ON" in an operation-ready status with the input of the start signal or during operation.
12	112	Y12	"ON" at the preset output current or higher. **Refer to: 8.7.4 Detection of output current**
14	114	FDN	Used for PID control operation. **Refer to: 8.6.3 PID control operation**
15	115	FUP	
16	116	RL	
25	125	FAN	Turns "ON" only when the cooling fan fails.
26	126	FIN	"ON" at 85% or higher of the heat sink overheat protection operation temperature or higher.
98	198	LF	Turns "ON" at a fan failure or communication error alarm. **Refer to: 8.5.8 Other settings** **Refer to: 8.6.2 Communication operation from the PU connector**
99	199	ABC	Turns "ON" when the protective function is activated to stop the output. **Refer to: Chapter 6 Troubleshooting**
9999	—		No function

MEMO	● The output terminal set for negative logic is reset when the RES signal is turned OFF after it has been turned ON once.

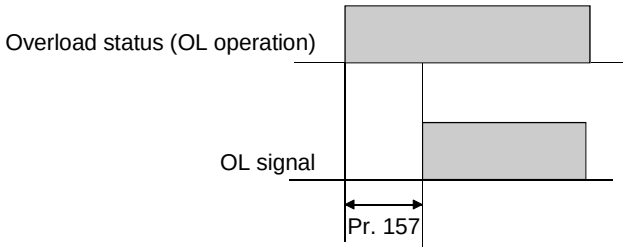
Initial value

Pr. 157 "OL signal output timer" 0

You can set the output timing of the OL signal.

Setting Range	Unit	Function
0	s	Output as soon as the stall prevention operation level is reached.
0.1 to 25.0	s	Output the preset period of time after the stall prevention operation level has been reached.

Refer to: 8.5.6 Stall prevention operation level



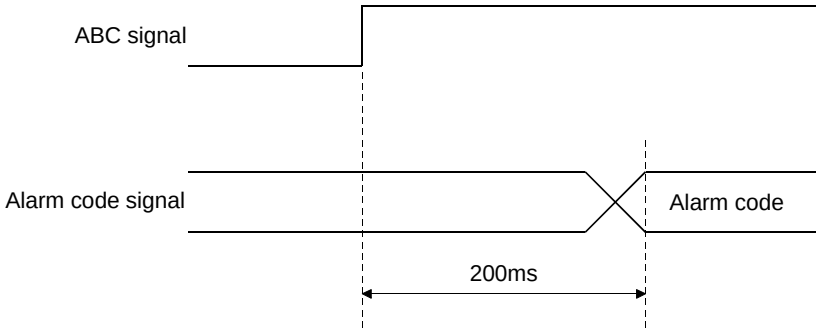
Initial value

Pr. 76 "alarm code output selection" 0

You can output the detected alarm code as a 4-bit digital signal from the control circuit transistor output terminals. The alarm code can be read using an external controller to display its remedy on the display.

Setting	Function
0	Alarm code is not output.
1	Alarm code output-only terminal.
2	The alarm code is output only at detection of the alarm. During normal operation, the function is the same as in "0" setting.

● Alarm code output timing



The operations of the control circuit transistor output terminals relative to the alarm codes are listed in the following table.

Alarm Code Displayed on Operation Panel (Actual Characters)	Logic of Output Terminals				Definition of Logic
	SU	IPF	OL	FU	
E.0C1 (E. 0C1)	0	0	0	1	Logic "0" indicates that the transistor output terminal is "OFF", and logic "1" indicates that the transistor output terminal is "ON".
E.0C2 (E. 0C2)	0	0	1	0	
E.0C3 (E. 0C3)	0	0	1	1	
E.0u1 ~ E.0u3 (E. 0V1 to E. 0V3)	0	1	0	0	
E.rHn (E. THM)	0	1	0	1	
E.rHr (E. THT)	0	1	1	0	
E.IPF (E. IPF)	0	1	1	1	
E.UuT (E. UVT)	1	0	0	0	
E.FIn (E. FIN)	1	0	0	1	
E. bE (E. BE)	1	0	1	0	
E. GF (E. GF)	1	0	1	1	
E.OHT (E. OHT)	1	1	0	0	
E.OLT (E. OLT)	1	1	0	1	
E.OPT (E. OPT)	1	1	1	0	
E. PE (E. PE)	1	1	1	1	
E.PUE (E. PUE)					
E.rET (E. RET)					
E.LF (E. LF)					
E.CPU (E. CPU)					
E. 6 ~ E. 7 (E. 6, E. 7)					

MEMO	
	● Refer to "Chapter 6 Troubleshooting" for details of the alarm codes. ● When this function is activated, Pr. 191 to 194 are disabled. ● This function is activated for the terminals SU, IPF, OL and FU only. It cannot be activated for the other terminals where the SU, IPF, OL and FU signals have been selected.

8.7.3 Detection of running speed

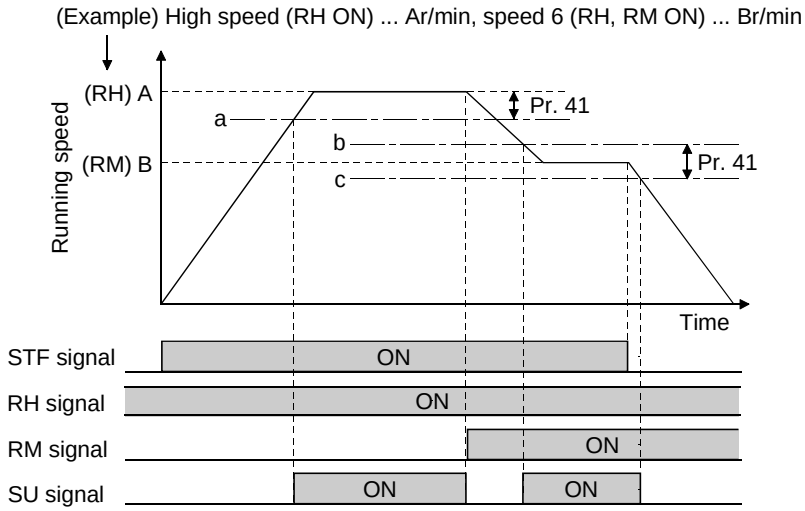
		Initial value
Pr. 41	**"up-to-speed sensitivity"**	**10**

Setting Range	Unit
0.0 to 100.0	%

Once the motor speed in response to the speed command has fallen within the range set in Pr. 41 can be exported from the control circuit output terminal where the SU signal has been assigned.

Refer to: 8.7.2 Selection of the control circuit output terminal functions

When the motor speed reaches the command value, it can be used as the operation start signal of the related equipment.



<Setting example>
When Pr. 41=10
a=0.9×A, b=1.1×B, c=0.9×C.

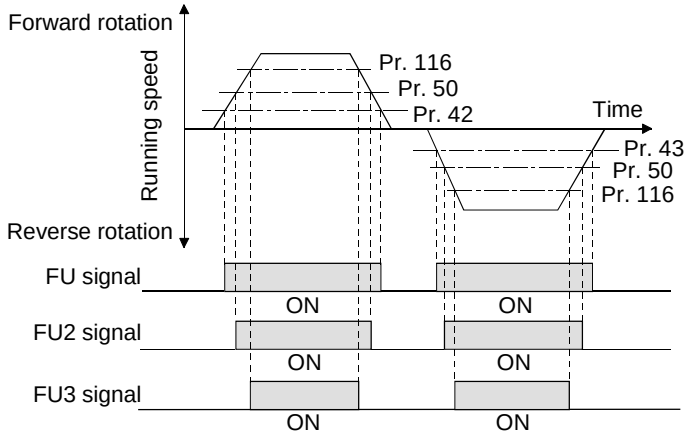
MEMO	● When using the analog signal or the operation panel's ▲▼ key to vary the speed, the SU signal may alternate between "ON" and "OFF". In this case, change the acceleration/deceleration time setting [Section 8.5.2] to "0".

		Initial value
Pr. 42	**"speed detection"**	**180**
Pr. 43	**"speed detection for reverse rotation"**	**9999**
Pr. 50	**"second speed detection"**	**900**
Pr. 116	**"third speed detection"**	**9999**

Pr.	Setting Range	Unit	Signal
42	0 to 3000	r/min	FU
43	0 to 3000	r/min	FU
	9999	—	—
50	0 to 3000	r/min	FU2
116	0 to 3000	r/min	FU3
	9999	—	—

Once the motor speed has reached or exceeded the speed set in the corresponding parameter, it is exported from the control circuit output terminals where the FU, FU2 and FU3 signals have been assigned.
Pr. 43 is valid for only the operation performed using the reverse rotation signal (terminal STR or REV key).
Setting the Pr. 43 value makes the Pr. 42 setting invalid for reverse rotation signal operation so that you can separate detection between forward rotation operation and reverse rotation operation.
Setting "9999" in Pr. 43 provides the same function as set in Pr. 42.
Setting "9999" in Pr. 116 makes Pr. 116 invalid.

Refer to: 8.7.2 Selection for the control circuit output terminal functions

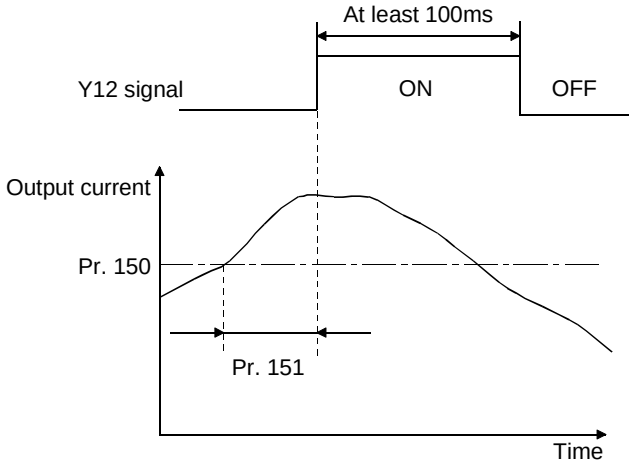


8.7.4 Detection of output current

		Initial value
Pr. 150	**"output current detection level"**	**150**
Pr. 151	**"output current detection time"**	**0**

Pr.	Setting Range	Unit
150	0.0 to 200.0	%
151	0.0 to 10.0	s

If the motor current remains higher than the Pr. 150 setting for longer than the time set in Pr. 151, the terminal where the assigned Y12 signal turns "ON". The Pr. 150 value is based on the rated motor current.
Use any of Pr. 190 to Pr. 195 [Section 8.7.2] to assign the terminal used for Y12 signal output.
Once turned on, the Y12 signal remains on for at least 100ms.



8.7.5 Selection of the instrument connection terminal functions

		Initial value
Pr. 54	**"FM terminal function selection"**	**1**
Pr. 158	**"AM terminal function selection"**	**1**

You can select the signals output to the FM and AM terminals designed for instrument connection.

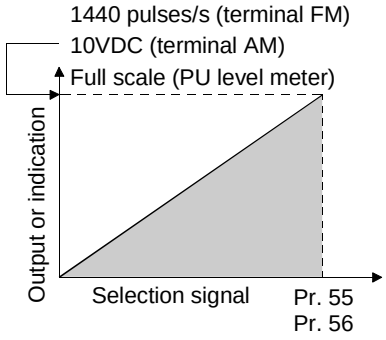
Setting	Display Data	Unit	Full-Scale
1	Motor speed	r/min	Value set in Pr. 55
2	Motor current	A	Value set in Pr. 56
3	Output voltage	V	400V
5	Preset speed	r/min	Value set in Pr. 55
8	Converter output voltage	V	400V
9	Regenerative brake duty	%	Value set in Pr. 70 [Section 8.5.5]
10	Electronic overcurrent protection load factor	%	Thermal relay operation level
11	Motor current peak value	A	Value set in Pr. 56
12	Converter output voltage peak value	V	400V
21	Reference voltage output	—	1440 pulses/s are output to terminal FM Full-scale voltage is output to terminal AM

MEMO	● The maximum number of pulses of the terminal FM is 2400 pulses/s. ● The maximum output voltage of the terminal AM is 10VDC. ● The output signals from the terminals FM, AM are updated at intervals of several 10ms.

		Initial value
Pr. 55	**"speed monitoring reference"**	**2000**
Pr. 56	**"current monitoring reference"**	**Rated motor current**

The terminal FM outputs a 1440 pulse/s signal at the value set in Pr. 55 or 56.
The terminal AM outputs a 10VDC voltage at the value set in Pr. 55 or 56.

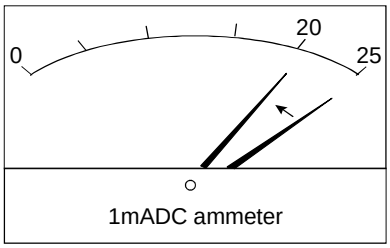
Pr.	Setting Range	Unit
55	0 to 3000	r/min
56	0.00 to 500.00	A



Pr. 900 "FM terminal calibration"

Using the operation panel or parameter unit, you can calibrate the full scale of a meter connected to the FM instrument connection terminal.
The terminal FM outputs a 1mADC current at the value set in Pr. 55 or 56. When the full scale of the meter used must be calibrated, it can be adjusted using Pr. 900.

<Calibration example>
Connect a 1mADC ammeter having a full-scale graduation "25" and adjust it to deflect to the graduation "20" at the running speed 2000r/min.



<Calibration procedure using operation panel>

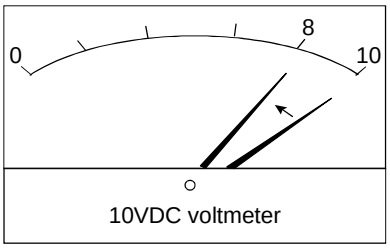
1) Make sure that "2000" has been set in Pr. 55.
2) Confirm that the (+) terminal of the meter is connected to terminal FM and the (-) terminal to terminal SD.
3) When a calibration resistor is connected on the meter side, adjust it until the resistance value is "0" or remove it.
4) Set the operation mode to the PU operation mode.
5) Set the running speed to 2000r/min.
6) Press the SET key.
7) Read Pr. 900.
8) Press the FWD or REV key to start operation. You need not connect the motor.
9) Using the ▲▼ key, make adjustment until the meter deflects to the graduation "20". Holding down the ▼ key decreases the current flowing in the ammeter. The ▲ key increases the current.
10) Press the SET key until Pr. 900 flickers. (About 2s)
11) Press the STOP/RESET key to stop operation.

MEMO	● Holding down the ▲ key increases the current to about 2mA. Check the maximum rating of the ammeter and make adjustment. ● You can also calibrate the meter for external operation. Set the frequency in the external operation mode and make calibration in accordance with steps 7) to 11). ● You can also make calibration during operation.

Pr. 901 "AM terminal calibration"

Using the operation panel or parameter unit, you can calibrate the full scale of a meter connected to the AM instrument connection terminal.
The terminal AM outputs a 10VDC voltage at the value set in Pr. 55 or 56. When the full scale of the used meter must be calibrated, it can be adjusted using Pr. 901.

<Calibration example>
Connect a 10VDC voltmeter having a full-scale graduation "10" and adjust it to deflect to the graduation "8" at the motor current 8A.



<Calibration procedure using operation panel>

1) Set "8" in Pr. 56 and "21" in Pr. 158.
2) Confirm that the (+) terminal of the meter is connected to terminal AM and the (-) terminal to terminal 5.
3) Set the operation mode to the PU operation mode.
4) Set the running speed.
5) Press the SET key.
6) Read Pr. 901.
7) Press the FWD or REV key to start operation. You need not connect the motor.
8) Using the ▲▼ key, make adjustment until the meter deflects to the graduation "8". Holding down the ▼ key decreases the voltage applied to the voltmeter. The ▲ key increases the voltage.
9) Press the SET key until Pr. 901 flickers. (About 2s)
10) Press the STOP/RESET key to stop operation.
11) Set 2 in Pr. 158.

MEMO	● When calibrating an item which cannot provide a 100% value easily by operation, e.g. motor current, set "21" in Pr. 158, perform calibration operation, and after completion of the calibration, set the selected display data value ("2" for motor current") in Pr. 158. ● For the calibration method using the parameter unit (FR-PU04), refer to the FR-PU04 instruction manual. ● You can also calibrate the meter for external operation. Set the frequency in the external operation mode and make calibration in accordance with steps 6) to 10). ● You can also make calibration during operation. ● Holding down the ▲ key increases the voltage to about 13.5V.

8.8 Control Parameters

Do not change the settings of these parameters since they have been factory-set to the optimum values.
When changing their settings, you need to set 801 in Pr. 77.

<Control parameters>

Initial value

Pr. 733 "motor protection electronic overcurrent protection value" 100

Pr.	Setting Range	Unit	Operation
733	0.0 to 200.0	%	You can change the operation reference torque of motor overheat protection.

⚠ CAUTION

Do not use Pr. 733 at more than the initial value 100.
If you use it by force-cooling the motor, consult the factory before using it.

Initial value

Pr. 728 "low speed region acceleration time" 5

Pr.	Setting Range	Unit	Operation
728	0.00 to 15.00	s	The maximum value of acceleration time in less than the speed control range (less than 100r/min) is specified. The reference speed for acceleration time is the rated speed 2000r/min.

⚠ CAUTION

Do not use Pr. 728 at more than the initial value 5.
Doing so may not provide the starting torque 150%.

Initial value

Pr. 713 "speed response time" 10

Pr. 714 "speed response adjustment" 100

Pr.	Setting Range	Unit	Operation
713	2 to 30	—	Both parameters can make speed response faster as the setting is increased.
714	20.0 to 300.0	%	

⚠ CAUTION

Increasing the Pr. 713 and Pr. 714 values can make speed response faster, but use them at their initial values since vibration may occur depending on the load conditions.
If vibration has occurred, decrease the Pr. 714 value.

Initial value

Pr. 71 "applied motor" 1

Pr.	Setting Range	Unit	Operation
71	1	—	Set the motor to be used.

Initial value

Pr. 80 "motor capacity"

Pr.	Setting Range	Unit	Operation
80	0.5, 1.0, 1.5, 2.0, 3.5	kW	Set the motor capacity. Set the same capacity as that of the drive unit.

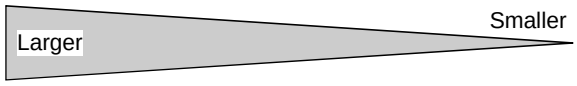
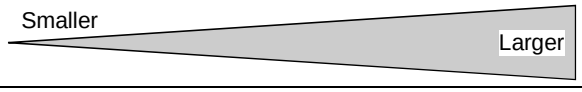
Note: Changing the Pr. 71 or Pr. 80 changes the motor-specific control constants used in the drive unit. Note that after changing the value, you need to make a reset.

Initial value

Pr. 736 "overspeed adjustment factor" 100

Pr.	Setting Range	Unit	Operation
736	0 to 100	—	Adjust overspeed (overshoot, undershoot).

The overspeed value depends on the load inertia, acceleration/deceleration time and load torque (friction torque).
Using the acceleration torque (proportional to load inertia/acceleration/deceleration time) and load torque (friction torque) to adjust the overspeed adjustment factor as outlined below allows overspeed to be suppressed effectively.

Overspeed Adjustment Factor	0 to 100
Load torque	
Acceleration torque	

Initial value

Pr. 737 "maximum voltage braking ending time (s)" 3

Pr.	Setting Range	Unit	Operation
737	0.0 to 60.0	s	Set the maximum voltage braking ending time when 9999 is set in Pr. 11 [Section 8.5.4] "voltage braking operation time". Normally, the motor stops running within about 3s. When it is rotated by external force, however, use this parameter to end voltage braking forcibly.

Initial value

Pr. 738 "stop time for operation reversion (s)" 0

Pr.	Setting Range	Unit	Operation
738	0.0 to 60.0	s	Set the stop time for switch-over from forward rotation to reverse rotation or from reverse rotation to forward rotation. If you set 0, there will be a stop time of at least about 100ms.

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
1	Maximum speed	0 to 3000r/min	3000		01	81	0	8-24
2	Minimum speed	0 to 3000r/min	0		02	82	0	
4	Three-speed setting (high speed)	0 to 3000r/min	2000		04	84	0	8-18
5	Three-speed setting (middle speed)	0 to 3000r/min	1000		05	85	0	
6	Three-speed setting (low speed)	0 to 3000r/min	500		06	86	0	
7	Acceleration time	0.0 to 3600s/ 0.00 to 360.0s	5		07	87	0	8-26
8	Deceleration time	0.0 to 3600s/ 0.00 to 360.0s	5		08	88	0	
9	Electronic thermal O/L relay	0, 1	1		09	89	0	8-32
10	Braking voltage operation speed	40 to 200r/min	100		0A	8A	0	8-29
11	Braking voltage operation time	0.0 to 60.0s, 9999	9999		0B	8B	0	
13	Minimum motor speed	40 to 100r/min	100		0D	8D	0	8-24
15	JOG speed	100 to 3000r/min	200		0F	8F	0	8-34
16	JOG acceleration/ deceleration time	0.0 to 3600s/ 0.00 to 360.0s	0.5		10	90	0	
17	MRS input selection	0, 2	0		11	91	0	8-21
20	Acceleration/ deceleration reference speed	1 to 3000r/min	2000		14	94	0	8-26
21	Acceleration/ deceleration time unit	0, 1	0		15	95	0	
22	Stall prevention operation level	0, 150%	150		16	96	0	8-31
24	Multi-speed setting (speed 4)	0 to 3000r/min, 9999	9999		18	98	0	8-18
25	Multi-speed setting (speed 5)	0 to 3000r/min, 9999	9999		19	99	0	
26	Multi-speed setting (speed 6)	0 to 3000r/min, 9999	9999		1A	9A	0	
27	Multi-speed setting (speed 7)	0 to 3000r/min, 9999	9999		1B	9B	0	

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
28	Contact input speed compensation	0, 1	0		1C	9C	0	8-20
29	Acceleration/ deceleration pattern	0, 1, 2	0		1D	9D	0	8-28
30	Regenerative brake option selection	0, 1, 2	0		1E	9E	0	8-30
31	Speed command jump 1A	0 to 3000r/min, 9999	9999		1F	9F	0	8-25
32	Speed command jump 1B	0 to 3000r/min, 9999	9999		20	A0	0	
33	Speed command jump 2A	0 to 3000r/min, 9999	9999		21	A1	0	
34	Speed command jump 2B	0 to 3000r/min, 9999	9999		22	A2	0	
35	Speed command jump 3A	0 to 3000r/min, 9999	9999		23	A3	0	
36	Speed command jump 3B	0 to 3000r/min, 9999	9999		24	A4	0	
37	Speed unit switch-over 1	0 to 9998	0		25	A5	0	8-55
41	Up-to-speed sensitivity	0.0 to 100.0%	10		29	A9	0	8-61
42	Speed detection	0 to 3000r/min	180		2A	AA	0	8-62
43	Speed detection for reverse rotation	0 to 3000r/min, 9999	9999		2B	AB	0	
44	Second acceleration time	0.0 to 3600s/ 0.00 to 360.0s, 9999	9999		2C	AC	0	8-27
45	Second deceleration time	0.0 to 3600s/ 0.00 to 360.0s, 9999	9999		2D	AD	0	
50	Second speed detection	0 to 3000r/min	900		32	B2	0	8-62
52	Main display screen data selection	Refer to manual description.	0		34	B4	0	8-56
53	Level display data selection	Refer to manual description.	1		35	B5	0	8-57
54	FM terminal function selection	Refer to manual description.	1		36	B6	0	8-64
55	Speed monitoring reference	0 to 3000r/min	2000		37	B7	0	
56	Current monitoring reference	0.00 to 500.00A	Rated motor current		38	B8	0	

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
59	Remote setting function selection	0, 1, 2	0		3B	BB	0	8-19
65	Retry item selection	0 to 5	3		41	C1	0	8-52
67	Retry count selection	0 to 10, 101 to 110	0		43	C3	0	
68	Retry time selection	0.0 to 10.0s	1		44	C4	0	8-53
69	Retry count display	0	0		45	C5	0	
70	Regenerative brake duty	0.0 to 15.0%	3		46	C6	0	8-30
72	Motor tone selection	1 to 4	1		48	C8	0	8-32
73	Speed command range selection	0 to 5, 10 to 15	0		49	C9	0	8-12
74	Filter time constant	0 to 8	1		4A	CA	0	8-13
75	Disconnected PU detection/PU stop selection	0 to 3	0		4B	CB	0	8-11
76	Alarm code output selection	0, 1, 2	0		4C	CC	0	8-59
77	Parameter write disable selection	0, 1, 2	0		4D	CD	0	8-6
78	Reverse rotation prevention selection	0, 1, 2	0		4E	CE	0	8-25
79	Operation mode selection	0 to 4, 6 to 8	0		4F	CF	0	8-8
84	Rated motor speed	Read-only			54	—	0	8-33
110	Third acceleration time	0.0 to 3600s/ 0.00 to 360.0s, 9999	9999		0A	8A	1	8-27
111	Third deceleration time	0.0 to 3600s/ 0.00 to 360.0s, 9999	9999		0B	8B	1	
116	Third speed detection	0 to 3000r/min, 9999	9999		10	90	1	8-62

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
117	Station number	0 to 31	0		11	91	1	8-35
118	Communication speed	48, 96, 192	92		12	92	1	
119	Stop bit length/data length	0, 1, 10, 11	1		13	93	1	
120	Parity check presence/absence	0, 1, 2	2		14	94	1	
121	Number of communication retries	0 to 10, 9999	1		15	95	1	
122	Communication check time interval	0, 0.1 to 999.8, 9999	0		16	96	1	
123	Waiting time setting	0 to 150, 9999	9999		17	97	1	
124	CR-LF presence/absence selection	0, 1, 2	1		18	98	1	
128	PID action selection	0, 10, 11, 20, 21	0		1C	9C	1	8-45
129	PID proportional band	0.1 to 1000%, 9999	100		1D	9D	1	
130	PID integral time	0.1 to 3600s, 9999	1		1E	9E	1	
131	Upper limit	0.0 to 100.0%, 9999	9999		1F	9F	1	
132	Lower limit	0.0 to 100.0%, 9999	9999		20	A0	1	
133	PID action set point for PU operation	0.00 to 100.0%	0		21	A1	1	
134	PID differential time	0.01 to 10.00s, 9999	9999		22	A2	1	
144	Speed unit switch-over 2	0, 1	0		2C	AC	1	8-55
150	Output current detection level	0.0 to 200.0%	150		32	B2	1	8-63
151	Output current detection time	0.0 to 10.0s	0		33	B3	1	
156	Stall prevention operation selection	1 to 31 (odd number), 101	1		38	B8	1	8-31

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
157	OL signal output timer	0.0 to 25.0s	0		39	B9	1	8-59
158	AM terminal function selection	Refer to manual description.	1		3A	BA	1	8-64
160	User group read selection	0, 1, 10, 11	0		00	80	2	8-6
171	Actual operation hour meter clear	0	0		0B	8B	2	8-57
173	User group 1 registration	0 to 999	0		0D	8D	2	8-6
174	User group 1 deletion	0 to 999, 9999	0		0E	8E	2	
175	User group 2 registration	0 to 999	0		0F	8F	2	
176	User group 2 deletion	0 to 999, 9999	0		10	90	2	
180	RL terminal function selection	Refer to manual description.	0		14	94	2	8-22
181	RM terminal function selection	Refer to manual description.	1		15	95	2	
182	RH terminal function selection	Refer to manual description.	2		16	96	2	
183	RT terminal function selection	Refer to manual description.	3		17	97	2	
184	AU terminal function selection	Refer to manual description.	4		18	98	2	
185	JOG terminal function selection	Refer to manual description.	5		19	99	2	
186	CS terminal function selection	Refer to manual description.	8		1A	9A	2	
187	MRS terminal function selection	Refer to manual description.	24		1B	9B	2	
188	RES terminal operation selection	0, 1	0		1C	9C	2	8-23
189	STF, STR terminal operation selection	0, 1	0		1D	9D	2	

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
190	RUN terminal function selection	Refer to manual description.	0		1E	9E	2	8-58
191	SU terminal function selection	Refer to manual description.	1		1F	9F	2	
192	IPF terminal function selection	Refer to manual description.	2		20	A0	2	
193	OL terminal function selection	Refer to manual description.	3		21	A1	2	
194	FU terminal function selection	Refer to manual description.	4		22	A2	2	
195	A, B, C terminal function selection	Refer to manual description.	99		23	A3	2	
199	User's initial value setting	0 to 999, 9999	0		27	A7	2	8-7
232	Multi-speed setting (speed 8)	0 to 3000r/min, 9999	9999		28	A8	2	8-18
233	Multi-speed setting (speed 9)	0 to 3000r/min, 9999	9999		29	A9	2	
234	Multi-speed setting (speed 10)	0 to 3000r/min, 9999	9999		2A	AA	2	
235	Multi-speed setting (speed 11)	0 to 3000r/min, 9999	9999		2B	AB	2	
236	Multi-speed setting (speed 12)	0 to 3000r/min, 9999	9999		2C	AC	2	
237	Multi-speed setting (speed 13)	0 to 3000r/min, 9999	9999		2D	AD	2	
238	Multi-speed setting (speed 14)	0 to 3000r/min, 9999	9999		2E	AE	2	
239	Multi-speed setting (speed 15)	0 to 3000r/min, 9999	9999		2F	AF	2	
244	Cooling fan operation selection	0, 1	0		34	B4	2	8-33
250	Coasting-to-stop setting	0.0 to 100.0s, 9999	9999		3A	BA	2	8-30
252	Override bias	0.0 to 200.0%	50		3C	BC	2	8-13
253	Override gain	0.0 to 200.0%	150		3D	BD	2	

APPENDIX 1 PARAMETER LIST (NUMERICAL ORDER)

No.	Name	Setting Range	Initial Value	Customer Setting	Instruction Code		Data	Refer to
					read	Write	Extension	
261	Power failure stop selection	0, 1	0		45	C5	2	8-54
262	Subtracted speed at deceleration start	0 to 600r/min	0		46	C6	2	
263	Subtraction starting speed	0 to 3000r/min, 9999	2000		47	C7	2	
264	Power-failure deceleration time 1	0.0 to 3600s/ 0.00 to 360s	5		48	C8	2	
265	Power-failure deceleration time 2	0.0 to 3600s/ 0.00 to 360s, 9999	9999		49	C9	2	
266	Power-failure deceleration time switch-over speed	0 to 3000r/min	2000		4A	CA	2	
900	FM terminal calibration	—	—		5C	DC	1	8-65
901	AM terminal calibration	—	—		5D	DD	1	8-63
902	Speed setting voltage bias	0.0 to 300.0% 0 to 2000r/min	Approx. 0 0		5E	DE	1	8-14
903	Speed setting voltage gain	0.0 to 300.0% 1 to 3000r/min	Approx. 100 2000		5F	DF	1	
904	Seed setting current bias	0.0 to 300.0% 0 to 2000r/min	Approx. 20 0		60	E0	1	8-17
905	Speed setting current gain	0.0 to 300.0% 1 to 3000r/min	Approx. 100 2000		61	E1	1	
990	Buzzer control	0, 1	1		5A	DA	9	8-33
991	LCD contrast	Parameter for option (FR-PU04)			5B	DB	9	—

REVISIONS

*The manual number is given on the bottom left of the back cover.

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